THE JOURNAL OF PROSTHETIC DENTISTRY

VOLUME 9 SEPTEMBER-OCTOBER, 1959 NUMBER 5

COMPLETE DENTURES
REMOVABLE PARTIAL DENTURES
FIXED PARTIAL DENTURES
OPERATIVE DENTISTRY

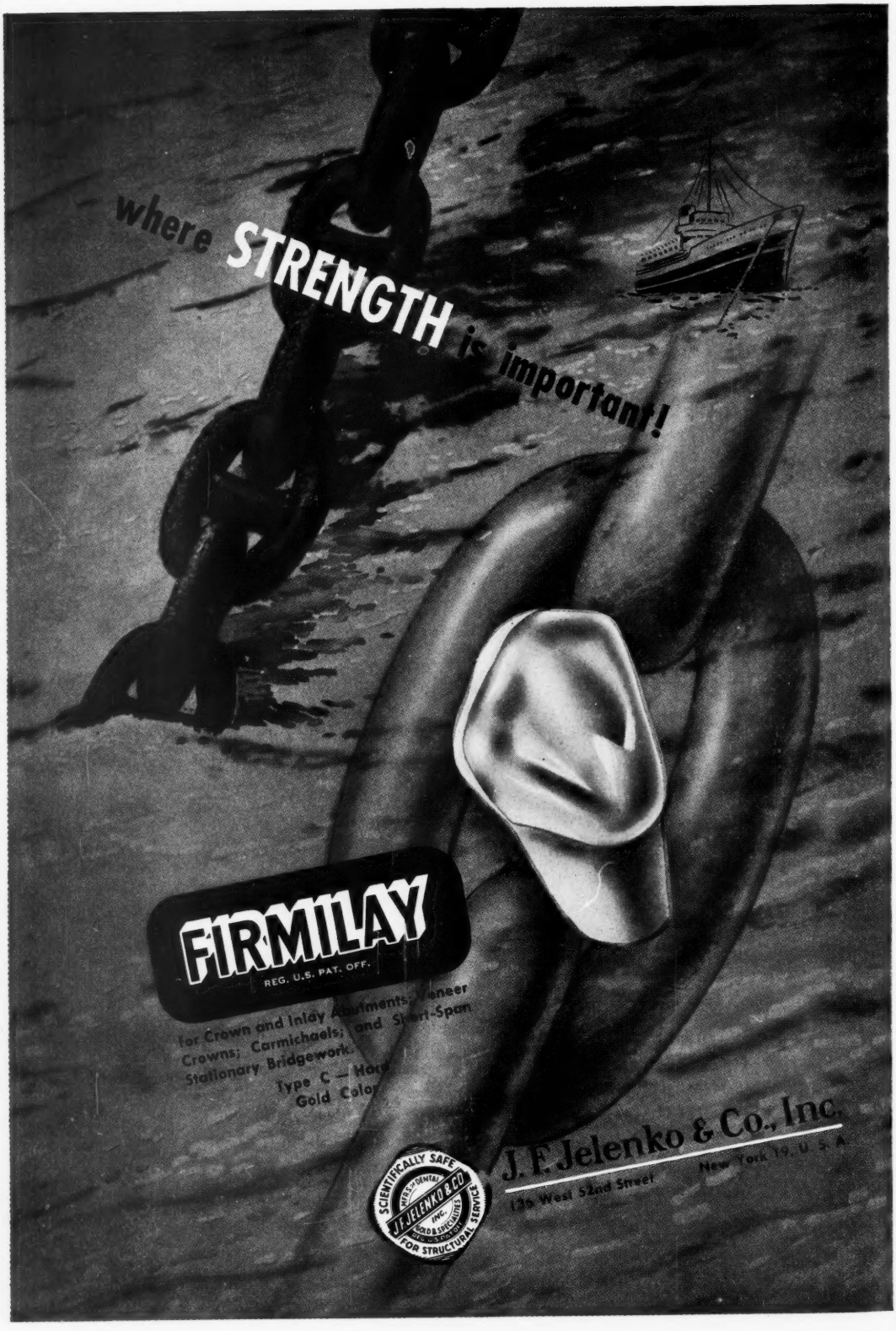
THE UNIVERSITY OF MICHIGAN
SEP 9 1959
DENTISTRY LIBRARY
C. 2

Official Publication of

THE ACADEMY OF DENTURE PROSTHETICS
THE AMERICAN DENTURE SOCIETY
THE PACIFIC COAST SOCIETY OF PROSTHODONTISTS
THE AMERICAN ACADEMY OF RESTORATIVE DENTISTRY
THE AMERICAN ACADEMY OF CROWN AND BRIDGE PROSTHODONTICS
THE GREATER NEW YORK ACADEMY OF PROSTHODONTICS
THE SOUTHEASTERN ACADEMY OF PROSTHODONTICS

PUBLISHED BY
THE C. V. MOSBY COMPANY, 3207 WASHINGTON BLVD., ST. LOUIS 3, U.S.A.

TABLE OF CONTENTS ON PAGE ONE



See New Products at the Jelenko Booths # 67 & 68
Chicago Mid-Winter Meeting

THE JOURNAL OF
PROSTHETIC
DENTISTRY

CONTENTS FOR SEPTEMBER-OCTOBER, 1959

Through the Eyes of the Editor.
Carl O. Boucher, D.D.S., Columbus, Ohio **705**

COMPLETE DENTURES

Three-Dimensional Photography in Prosthodontics.
Cecil H. Bliss, D.D.S., Sioux City, Iowa **708**

The Use of the Face-Bow in Making Permanent Study Casts.
T. D. Foster, B.D.S., F.D.S.R.C.S., Aylesbury, Bucks, England **717**

The Dental Aspect of Esthetics.
Oscar E. Beder, B.S., D.D.S., Seattle, Wash. **722**

Effective Use of Diagnostic Data.
Samuel Friedman, D.D.S., New York, N. Y. **729**

The Influence of Immediate Dentures on Tissue Healing and Alveolar Ridge Form.
Ellsworth K. Kelly, Colonel, DC, USA, and Raymond F. Sievers, D.D.S., Washington, D. C., and Bellevue, Wash. **738**

Mucosal Edema: A New Syndrome.
Romie H. Miller, Jr., D.D.S., B.S.D.S., Clayton, Mo. **743**

Improvement of Tissues for the Support of Dentures.
Claud M. Fraleigh, Captain (DC) USN, San Francisco, Calif. **746**

An Evaluation of Denture Adaptation on the Basis of Contour Meter Recordings.
Gunnar Ryge, D.D.S., M.S., and Carl W. Fairhurst, M.S., Milwaukee, Wis. **755**

The Role of Exteroceptors in Denture Retention.
N. Brill, L.D.S., G. Tryde, L.D.S., and S. Schübeler, L.D.S., Copenhagen, Denmark **761**

A Study of Vertical and Centric Relations by Means of Cranial Roentgenology.
T. A. Bodine, D.D.S., Akron, Ohio **769**

The Transverse Hinge Axis: Real or Imaginary.
Lawrence A. Weinberg, A.B., D.D.S., Brooklyn, N. Y. **775**

More on the Bennett Movement.
Raymond Cohen, D.D.S., New York, N. Y. **788**

The Effect of Bonwill's Triangle on Complete Dentures.
Finn Tengs Christensen, L.D.S., Stavanger, Norway **791**

(Continued on page 3)

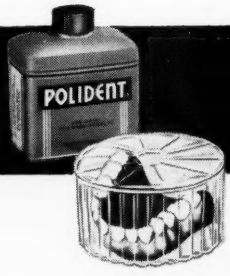
"POLIDENT-CLEAN" dentures pass the test of personal proximity

reflecting credit upon your skill

Patients appreciate your recommendation of Polident for cleaning dentures the safe, easy way. Polident floats away debris, removes stains—leaves dentures fresh, sparkling, odor-free and pleasant to wear. Its gentle soak and rinse action won't mar the lustrous finish and delicate detail which are evidence of your professional skill. Recommend Polident to all your denture patients.

recommended by more dentists than any other denture cleanser

POLIDENT®



For office supply of samples, write

BLOCK DRUG COMPANY, INC.

105 Academy Street, JERSEY CITY 2, N.J.

Contents for September-October, 1959—Continued

Curved Occlusal Planes Are Contraindicated.
Honorato Villa A., D.D.S., Mexico, D. F. **797**

Condyle Path Tracer for Diagnosis.
Honorato Villa A., D.D.S., Mexico, D. F. **800**

Technique for Arranging Posterior Teeth.
Honorato Villa, A., D.D.S., Mexico, D. F. **803**

The Adaptability of Posterior Teeth.
Honorato Villa A., D.D.S., Mexico, D. F. **810**

Design of Posterior Teeth.
Honorato Villa A., D.D.S., Mexico, D. F. **814**

Eliminating a Health Hazard in Prosthodontic Treatment of Patients With Pulmonary Tuberculosis.
M. A. Pleasure, D.D.S., M.S.P.H., Edith L. Duerr, Ph.D., and Milton Goldman, B.S., Bronx, N. Y. **818**

Instructions to Denture Patients.
William G. Maison, D.D.S., San Francisco, Calif. **825**

What the Patient Should Know About Complete Dentures.
Joseph George Naylor, D.D.S., Howell, Mich. **832**

The History of Prosthetic Dentistry.
Wallace W. Johnson, B.S., D.D.S., M.S., Iowa City, Iowa **841**

FIXED PARTIAL DENTURES

Porcelain Fused to Iridio-Platinum Crowns.
Arthur S. Freese, D.D.S., New York, N. Y. **847**

Incisal and Condylar Guidance in Relation to Cuspal Inclination in Lateral Excursions.
Lawrence A. Weinberg, A.B., D.D.S., Brooklyn, N. Y. **851**

The Telescopic Type of Fixed Partial Denture Abutment.
Gerald J. Steinberg, D.D.S., Philadelphia, Pa., and Washington, D. C. **863**

OPERATIVE DENTISTRY

Practical Application of Tooth Morphology.
Charles Schroeter, Seattle, Wash. **867**

MISCELLANEOUS

Maximum Mouth Protection for Contact Sports.
William D. Heintz, B.A., D.D.S., Columbus, Ohio **874**

Counsel to the Aging Dental Patient.
Eldon D. Bills, D.D.S., M.S., Iowa City, Iowa **881**

Dentist and Dental Laboratory Technician Relations.
Academy of Denture Prosthetics **886**

Editorial **889**

Book Reviews **890**

News and Notes **892**

Directory **896**

Vol. 9, No. 5, September-October, 1959. Journal of Prosthetic Dentistry is published by the C. V. Mosby Company, 3207 Washington Blvd., St. Louis 3, Mo. Subscription rates: United States and Its Possessions $12.00, Students $6.00: Canada, Latin-America, and Spain $12.50, Students $6.50; Other Countries $13.00, Students $7.00. Single copies, $2.50 postpaid. Entered as second-class matter March 13, 1951, at the Post Office at St. Louis, Missouri, under the Act of March 3, 1879. Additional entry authorized at Jefferson City, Missouri. Printed in the U. S. A.

Copyright © 1959 by the C. V. Mosby Co.

PORCELAIN-LINED ACRYLIC JACKETS

and

PORCELAIN-ENAMEL LINED ACRYLIC VENEERS AND BRIDGEWORK *by*

NU-DENT

The opaque porcelain core of our porcelain-lined acrylic jackets offers an ideal cementing medium and base upon which to build up the acrylic shades! It permits use of Nu-Dent's beautiful life-like translucent shades without possibility of their being affected by the cement used.

Now . . . we have a technique of firing acrylic under dry heat, which gives our newly formulated acrylic a porcelain-like glaze and sheen and greater resistance to wear. Testing laboratory reports establish the fact that Nu-Dent acrylic is 2½ times as resistant to wear as other present day acrylics.

Only *Nu-Dent's* technique for Porcelain-Enamel Lined Acrylic Veneers and Bridgework involves masking the gold by baking the porcelain enamel to it. Because of this chemical bond, there can be no breaking away from the gold. Seepage and discoloration are permanently eliminated . . . the acrylic veneer maintains its beautiful color permanently.

All Nu-Dent porcelain restorations are fired in exclusive patented Vacuum Furnaces.

nu-dent PORCELAIN STUDIO, INC.
(Reg. U.S. Pat. Off.)
220 West 42 St., N.Y. 36, N.Y. • Phone—LA 4-3591, 2, 3, 4, 5, 6
9615 Brighton Way, Beverly Hills, Cal., Phone—CRestview 5-8717

(Send to NU-DENT Studio Nearest You)
NU-DENT PORCELAIN STUDIO, Inc.
Please send information on practice-building NU-DENT porcelain restorations.
Dr._____
Address_____
City & Zone _____ State_____

THE JOURNAL OF
PROSTHETIC
DENTISTRY

SEPTEMBER-
OCTOBER, 1959
VOLUME 9
NUMBER 5

THROUGH THE EYES OF THE EDITOR

Cecil H. Bliss discusses the use of three-dimensional photography in prosthodontics and describes his techniques for using it. He sees tremendous advantages in the use of this type of pre-extraction record because it helps him achieve his esthetic objectives. He favors the accurate reproduction of the patient's teeth over an impressionistic approach to esthetics. Both of these philosophies can be effective when they are properly used. Unfortunately, there are too many who ignore both the reproductionistic and the impressionistic philosophies and arrange the anterior teeth with mechanics alone as their objective. There can be no doubt of the value of photography for making pre-extraction records, but, as is stated in this article, other types of records are needed also for a complete record of the appearance of the patient and the teeth.

T. D. Foster describes his method for making pre-extraction records. He uses a face-bow and a special platform for orienting the casts. The platform makes it possible to relate the study casts to each other without the use of an articulator and to orient them to show existing asymmetries. The procedure and the records will help in the reproduction of tooth inclinations in dentures.

Oscar E. Beder discusses the dental aspect of esthetics especially as it may be applied to cleft palate patients. However, similar variations and limitations apply to the treatment of edentulous patients. The basic skeletal frame about the oral cavity can be altered within limits by dentures and thus improve the appearance of patients. The shape of the restoration is important in developing support for the soft tissues.

Samuel Friedman discusses the use of diagnostic data for prosthodontic treatment. He points out the information which is necessary, and, unlike most articles on this subject, he tells what to do about the information after it is secured. If an unfavorable condition can be improved, he suggests a means for improving it. If it cannot be improved, he warns about the difficulties that will affect the progress of the work or the comfort of the patient.

Ellsworth K. Kelly and Raymond F. Sievers report their studies of the influence of immediate dentures on the healing of tissues and on the form of the residual ridges. This is a problem about which many statements have been made on the basis of clinical observations *in different mouths.* Their observations and comparisons were made in the same arch and at the same time. On the basis of these clinical tests and histologic sections, they conclude that there are advantages to the soft tissues only in the first 48 hours after surgery and that the ridges were improved by the stimulation by the dentures. More studies of this nature should be carried out.

Romie H. Miller, Jr., discusses the changes that occur in the mucosa as a result of the emotional impact of the impression procedures. He calls this response mucosal edema. There can be no doubt about the emotional reaction of some patients. The suggestion of an edema occurring as a result of this seems to need further study. If the edema does occur, it

would be logical to expect more of a reaction at the first insertion of the impression material. A one-shot impression would be less likely to be accurate on this basis than an impression that was made by a series of steps. This suggestion should be studied further before valid conclusions can be drawn.

Claud M. Fraleigh discusses the histology of some of the soft tissues on which dentures are placed and suggests a surgical procedure for improving the quality of this support. The idea of broadening the area of close and firm attachment of these soft tissues to the bone seems to be sound. It is worthy of further study because tissues other places in the body that withstand external pressure well are closely attached to the underlying bone.

Gunnar Ryge and Carl W. Fairhurst report on their comparison of the warpage and dimensional changes in denture bases formed by different processing methods. The test bases were measured by their contour meter. The method seems to have practical advantages over some other test methods. They found certain "inherent advantages" of some processing methods over compression molding but warn that no one of the "newer methods" can be claimed to be superior to the others on the basis of this work.

N. Brill, G. Tryde, and S. Schübeler report their studies of the part muscle function plays in maintaining dentures in position. They measured the force required to unseat dentures without and with surface anesthesia of the oral tissues. Their results indicate that the musculature, as guided by the exteroceptors, plays a most important role in the retention of dentures. On this basis, the shaping of the "polished" surfaces of dentures should be given adequate consideration in order to assist the musculature to do its part. Also, their results explain why patients with apparently equal denture foundations may have unequal success in wearing dentures.

T. A. Bodine reports on his study of vertical dimension and centric relation by means of cephalometric roentgenograms. The experimental method shows promise of contributing valuable additional information about jaw relationships. His observations and conclusions indicate the desirability of making jaw relation records without contacts between the opposing occlusal surfaces.

Lawrence A. Weinberg discusses the transverse hinge axis and points out the reasons for the differences in opinions about it. He describes the transverse hinge axis and compares clinical uses of it. He concludes that the axis does exist but points out difficulties in its accurate registration. This analysis seems to be sound because it allows for consideration of the physiology of the temporomandibular joints. These joints are not precise mechanical devices, and, consequently, they are subject to variations similar to those of other living tissues. However, the variations do not excuse a failure to make jaw relation records as accurately as possible within the limits of practicality.

Raymond Cohen discusses the importance of the Bennett movement as a component of lateral mandibular movement. He considers any lateral translation of either condyle as being a "Bennett movement." There are two other concepts of this movement. They are: (1) that it consists of a directly lateral (outward) movement of the working-side condyle which occurs during lateral excursive movements, and (2) that it consists of a lateral shift of the condyles occurring during opening movements of the jaw. It appears that his concept involves the arcing rotation of the *mandible* in the horizontal plane. Naturally, this movement of the *mandible* would cause the balancing-side condyle to move toward the midline regardless of the existence of translatory movements of the working-side condyle. It is too bad we cannot ask Bennett just what is the Bennett movement, or perhaps we should discuss these problems by using more specific terms.

Finn Tengs Christensen discusses the effect of Bonwill's triangle on complete dentures and relates it to the height of cusps. He shows that variations in the length of the sides of the triangle cause variations in the Christensen angle, and this requires variations in cusp height. The results indicate that articulators should have variable intercondylar distances.

Honorato Villa A. discusses the contour of occlusal curvatures and reports his experiments on the "chew-in" method of developing the occlusal curvature. He concludes that the use of curved occlusal planes is contraindicated. Further experimentation would show that the resultant curvature can be varied, even with the same guiding controls (Moses, C. H.: Studies in Articulation, J. Pros. Den. 2:347-352, 1952).

This author discusses the use of the condyle

path tracer for diagnosis and describes his method for using it for this purpose. It is a graphic method and not too difficult to use.

His technique for arranging posterior teeth is based upon the elliptical principle he has suggested in this series of articles. The procedure is adaptable to various kinds of teeth (occlusal surfaces), and the resulting occlusion is related to the maxillary teeth.

He also discusses the range of adaptability of posterior teeth. He concludes that the currently available teeth are incorrect because they have been carved to conform to inadequate articulators.

He also describes the procedures he used to carve posterior teeth which meet the requirements of his elliptical theory of occlusion. The carvings allow for more latitude in arrangement (without grinding) than some other teeth and yet are in precise harmony with the guidances he has established.

M. A. Pleasure, Edith L. Duerr, and Milton Goldman discuss the health hazard involved in constructing dentures for patients with pulmonary tuberculosis. They report their experiments to determine an effective means for sterilizing the equipment and materials used for these patients. The destructible nature of most prosthodontic materials makes this problem more difficult than is apparent at first.

William G. Maison discusses a neglected phase of prosthodontics—the instructions to denture patients. Too often patients are told simply, "They are your teeth now, and you must learn to use them." This type of instruction is inadequate. The author has written his instructions so that his patients can understand what to expect, what to do, and how to use their new dentures. His article is directed to the patient rather than to the dentist, but it should assist both.

Joseph George Naylor discusses patient education. He explains to the patient the various kinds of dentures and some of the procedures used in making dentures. He also discusses with the patient various objectives of denture service and gives him advice about the care and service which dentures require.

Wallace W. Johnson reviews the history of prosthetic dentistry. The progress that has been made is truly remarkable. Sometimes we do not realize this because the changes have been so gradual. The research which has been done in the last 150 years has made a tremendous improvement in the quality of service in this branch of dentistry.

Arthur S. Freese compares porcelain fused to iridio-platinum crowns with porcelain jacket crowns. He concludes that the combination of metal and porcelain restorations provides the most benefit to the patient from the standpoints of durability and esthetics. He describes his technique for using these restorations in major occlusal rehabilitation.

Lawrence A. Weinberg discusses the relationships of the incisal and condylar guidances to the cusp inclines in lateral gliding movements. He analyzes each factor involved in relation to each of the other factors and compares different types of occlusal curvatures. His conclusions seem to be logical, although not everyone will agree with them.

Gerald J. Steinberg suggests the use of a telescopic type of pontic for use as an abutment for fixed partial dentures in unfavorable situations. This technique can simplify some very difficult situations where the tooth preparations cannot be made parallel.

Charles Schroeter discusses the practical application of tooth morphology to operative procedures. He suggests a logical and efficient system of carving which should accomplish the desired results in a minimum of time. He sets up specifications for the restored forms of teeth which can serve as guides for any tooth carving, regardless of the material or extent of the restoration in or on a tooth.

William D. Heintz discusses mouth protection for athletes engaged in contact sports and compares the relative merits of various types of mouth guards. Since dentists know better than others of the permanent damage that can result from a bump in the mouth, they should take the lead in supplying this protection. This author describes his technique for fabricating the mouth guards, and it is a simple procedure which is practical and effective. This is a public service opportunity which should not be overlooked.

Eldon D. Bills discusses some of the problems of aging as they relate to dental care. These problems are of increasing concern to dentists because of the increasing number of older people. Much of the comfort and happiness of older people depends upon their health, and their dental health is an important facet of their over-all health.

—Carl O. Boucher

COMPLETE DENTURES

THREE-DIMENSIONAL PHOTOGRAPHY IN PROSTHODONTICS

CECIL H. BLISS, D.D.S.
Sioux City, Iowa

THE HISTORY OF PROSTHODONTICS has been characterized by marked differences of opinion regarding practically all of the technical aspects of denture construction. Yet, despite conflicting ideas concerning the fabrication of dentures, once they are completed and inserted in the mouth it is universally agreed that they should look as natural as possible.

This desire for naturalness is by no means confined to members of the dental profession. It is also enthusiastically shared by most denture patients, especially those who face the possible loss of their teeth.

This fact was disclosed in a survey conducted some time ago, the results of which were reported in a previous article.[1] People selected at random were asked this question, "If you were to lose your teeth, what about that experience would concern you most?" Two persons wanted more than anything else to be comfortable, but all the others were most fearful that they might "never look the same again."

There is ample justification for this widespread concern. Almost everyone remembers a relative, a friend, or an acquaintance who visited the oral surgeon as one individual and reappeared a few weeks later wearing dentures that gave him an entirely different appearance. Such esthetic monstrosities masquerading as substitutes for the lost teeth are enough to strike terror in the hearts of any prospective denture patient.

Despite the ever-present need to re-emphasize the various steps that can be taken to achieve naturalness in denture construction, this article will not concern itself primarily with that phase of a most interesting subject. While several recognized procedures will be mentioned, the primary purpose will be to focus attention on the role "3-D" photography can play in preserving and maintaining natural appearance and to suggest its use as an extremely effective aid in case presentation.

Read before the Academy of Denture Prosthetics in Detroit, Mich., May 8, 1958.
Received for publication May 9, 1958.

IMPRESSIONISTS VERSUS REPRODUCTIONISTS

Among those dentists particularly interested in the appearance phase of denture construction, there seems to be two slightly different philosophies concerning the better method of achieving an esthetic result. One group could be called "impressionists" or "illusionists" and the other "reproductionists" or "realists."

The "impressionists" approach the problem much like the artist who, by the skillful use of paints which have little resemblance to the subject matter involved, seeks to capture on canvas a certain effect which will *appear* real and lifelike. Those who follow this concept in prosthodontics also strive for certain pleasing effects by the skillful placement of teeth and the treatment of the matrix material. Members of this group are not as interested in the reproduction of existing arrangements as they are to "create the illusion of reality."[2]

The "reproductionists," hoping to achieve the same over-all result, pursue a slightly different course in attempting to solve the esthetic problem. Those who believe in this philosophy evidence more interest in natural tooth arrangement and in the appearance of patients before the teeth are lost. These dentists continually emphasize the importance of properly recording the natural appearance before the opportunity is lost forever. They feel that true art is best expressed by imitating or reproducing, as nearly as is humanly possible, the arrangement and contours that are characteristic of the individual.

Obviously, there is considerable merit to both points of view. For some patients, a reproduction of existing conditions would be definitely undesirable, and for many patients, there is no choice for the simple reason that there are no pre-extraction records. Under these circumstances, the dentist must use all of his skill and artistic ability to create for the patient his conception of an appearance that will give the illusion of naturalness.

Several developments in recent years have made this task easier. There has been a marked improvement in the materials from which dentures are made. Admittedly, these improvements have been helpful, but by far the most noteworthy advancement came not as a result of better materials but because of the development of a better understanding of certain artistic principles in denture construction.[2,5]

APPROACH OF THE REPRODUCTIONISTS

Considering all of the factors that influence the appearance of dentures, whether they stem from the suggestions of the "illusionists" or the "reproductionists," I favor the "realistic" approach to the solution of the problem. It has always seemed wiser and artistically more correct to reproduce, whenever possible, the size, color, arrangement, and position of the natural teeth. There seems to be a certain "appropriateness" or "rightness" in a reproduction even though the arrangement or position of the teeth might be classed by some standards as unflattering or even bordering on the unsightly.

Admittedly, there are exceptions, but for the vast majority of patients, it is far more important that dentures look natural than beautiful. Very few people, after hearing a full and careful explanation, actually have the desire to "break in

a new face" along with the new dentures. It is not a pleasant thought to face the possibility of having to be reintroduced to family and friends. The truth of the matter is simply this—*Naturalness is Beauty.*

In making the foregoing statements no criticism of any approach having for its goal the construction of more natural-appearing dentures is intended or implied. I merely indicate a decided personal preference for a procedure that calls for complete pre-extraction records and photographs which permit a duplication if desired, or furnish a basis from which deviation may be made when indicated.

Because of this intense interest in preserving a permanent record of the patient's natural appearance, I have made it routine procedure to obtain complete pre-extraction records whenever possible. This procedure has varied little in thirty-five years with the exception of a recent shift to a completely different and a most interesting type of photography.

Photography alone, regardless of its value, cannot be classed as sufficient in itself. Complete records such as study casts, facial measurements, profile records, and other information concerning the shade and size of teeth are needed.

PRE-EXTRACTION RECORDS

Study casts should be considered an absolute necessity even when there are only a few teeth remaining. They furnish valuable information regarding the size, shape, and position of the teeth. Also, when opposing edentulous spaces are present, it is often possible to measure accurately interridge distances. Furthermore, a collection of study casts offers the student of esthetics an excellent opportunity to study and observe the infinite variations and subtle beauty that can be found in natural tooth arrangements. These and many other advantages make study casts one of the most important of all pre-extraction records.

Despite the continual re-emphasis of their value by authors and clinicians, it is tragic to note the shocking number of people who are permitted to suffer the loss of all of their teeth without so much as a notation about them having been made. With modern materials, it takes but a few moments to make impressions or to obtain a very accurate two-sectioned face piece, as suggested by Warburton.[3] Failure to offer patients the opportunity to have either is inexcusable.

FACIAL MEASUREMENTS

Facial measurements should be recorded also. There are several useful instruments available for this purpose, all of which can be used to advantage. However, the procedure as outlined by McGee[4] and Pound,[5] applied to the dentulous patient, seems adequate and much more practical.

FACE MASKS

For a time, face masks enjoyed a wave of popularity. While they offered some advantages, the complicated, time-consuming technique and the difficulty of finding storage space for them soon relegated this procedure to the background.

TEMPLATES

Profile templates are a most helpful guide. They can be made by using soft iron wire, tape and plaster, profile roentgenograms, exact size photographs, or photographic enlargements.

PRE-EXTRACTION PHOTOGRAPHS

Pre-extraction photographs, whether made in black and white or color, are a necessity for the discriminating dentist. A wide variety of choice in equipment designed specifically for that purpose is available, and it is limited only by personal preference and the amount of money to be invested in it.

I have experimented with several types of photographic techniques. Originally, photographs of patients were made by positioning the head in the "V" formed by two mirrors placed at right angles to each other. In this way, each picture showed three different views of the patient. The results were quite satisfactory, and this procedure was used for several years.

INTRODUCTION OF THREE-DIMENSIONAL PHOTOGRAPHY

Then followed a succession of cameras and various types of lighting equipment, until about ten years ago when an entirely different camera became available. Instead of having the customary single lens, this camera had two lenses which were synchronized to make two pictures simultaneously. When the two views were properly mounted and placed in a viewer, the result was an addition to the picture of a lifelike third dimension—depth. The beauty and the striking realism of the pictures are so impressive that all photography in my office is done in "three dimension."

CHOICE OF EQUIPMENT

Several years' experience with various types of equipment have taught one very valuable though quite expensive lesson. Any procedure to be practical in the dental office must be comparatively simple and not too time consuming. The large amount of costly, dust-laden equipment that can be found in many offices bears mute testimony to the truthfulness of this statement. There are many stereographic cameras on the market, but less than a dozen can be used for clinical photography. From these, I have chosen the Stereo Realist* and have been using it routinely.

STEREO REALIST CAMERA

The Stereo Realist is a sturdy, precision-made instrument well suited for this type of clinical photography (Fig. 1). The matched coated lenses are 70 mm. apart, which is the average pupilary distance. Since the diaphragms of the two lenses are coupled mechanically, when the rim of either lens is rotated, this automatically sets both lenses alike.

*The David White Company, Milwaukee, Wis.

The viewing lens is located midway between the picture-taking lenses, thus eliminating viewfinder parallax. Focusing is accomplished by rotating a milled wheel at the right end of the camera body. The range finder is a coupled, split-image, military type.

There is also a built-in flash synchronizer and synchronization shoe on the top of the camera which accommodate the flashgun. The camera comes in various price ranges, but the one we have been using is the ST-41 model with F/3.5 lenses.

ACCESSORIES

In order that the camera may be adapted to the full extent of its capabilities, some accessories are needed (Fig. 1). These are: the flashgun, flash shield, sun shades to take series 5 filters, number 1 Portra lenses, cable release, and a tripod (elevator type preferred).

PHOTO FLASH

The regular photoflash attachment fits snugly into the synchronization shoe located directly in the center of the top of the body frame. For distances up to 2.5 feet this serves very well.

When making pictures with the camera as close as 20 inches to the patient, a problem develops. With the center of the light eminating from a point in the reflector 4 inches above the taking lenses, the point of greatest light intensity strikes the patient at about the level of the forehead. This can be overcome by substituting a short synchronization cord for the rigid attachment to the camera. Then the reflector can be tilted slightly downward to bring about a better distribution of light over the entire field.

A flash shield should be used at all times for two reasons. First, it protects the patient in the event of a possible explosion of one of the flash bulbs. Second, it gives a softer light when the diffusing side of the shield is used, thus improving the quality of the pictures.

LENSES AND FILTER HOLDER

The sunshade and filter holders are the means by which the number 1 Portra lenses are held in place. The sunshade is unscrewed, permitting the lenses to be dropped in place and held in the proper position. When reassembled, the sunshades are then pressed over the outside of the picture-taking lenses and are retained by friction.

CABLE RELEASE

A cable release is not a necessity, but its use eliminates the possibility of camera movements.

ELEVATOR TRIPOD

One of the most useful accessories is the elevator tripod. With the ordinary tripod, a time-consuming adjustment in the length of its legs is necessary when a

change in vertical position is desired. With an elevator tripod, only one setting of the legs is necessary, and all further alterations are made by merely turning a crank.

BACKGROUND

The choice of a background has been the subject of considerable discussion. Some feel it should be a neutral color, while others favor the pastel shades, light bluish green being quite popular. We have been experimenting with a red background and have found it to be quite satisfactory.

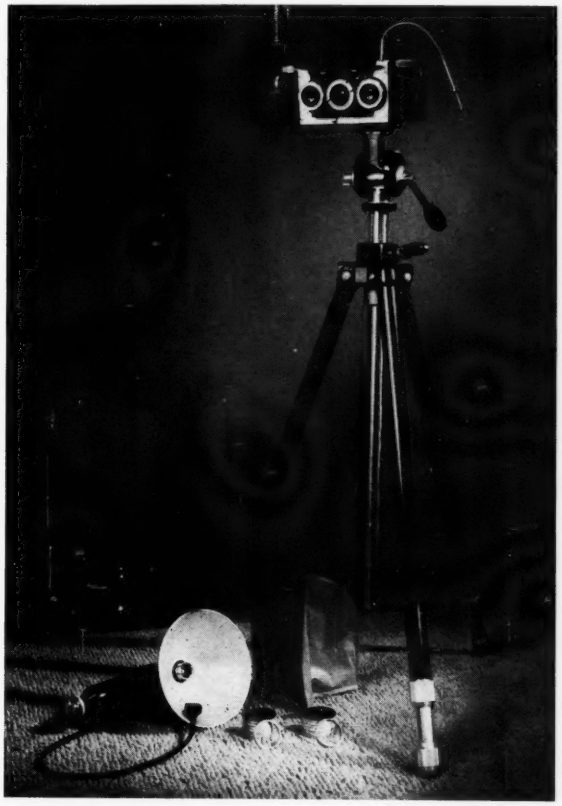


Fig. 1.—The equipment: Stereo Realist camera, cable release, tripod, flashgun, flash shield, and Portra lenses.

A simple and effective background can be made by cutting a 3 by 3 foot piece from a section of Masonite board. This can be sprayed or painted with the color of choice, possibly a different color on either side.

FILM AND FLASH BULBS

Very acceptable results have been obtained with the daylight-type color film and blue flash bulbs. This has the advantage of eliminating the inconvenience of

changing film when outdoor pictures are desired. While it seems difficult to detect the differences, Type F Kodachrome film gives better results when used with clear, gas-filled (SM or SF) flash bulbs.

The complete setup of the camera and accessories are shown with a patient in position for photography in Fig. 2.

Fig. 2.—The camera setup and patient posed before a suitable background.

PROCEDURE

When making stereoscopic pictures at close range, certain facts concerning this type of photography must be clearly understood.

First, since the two lenses cannot be turned in as the camera approaches the subject, there is a practical limit to the minimum camera-subject distance. Without special equipment, the limit is thirty inches.

Second, in the close-up ranges, the distortion will be exaggerated and depth decreased, giving an elongated appearance to the face anteroposteriorly. Therefore, when making close-ups with number 1 Portra lenses, patients must be posed with extreme care. The lenses should be on a level with the center of the head, and the face should be at right angles to the camera (Fig. 2). Any tilting of the head greatly exaggerates the distortion. Therefore, all clinical pictures are made in the 20 to 36 inch range. For pre-extraction photography, 6 views are made.

The first two pictures, a straight front and a profile with the teeth in light contact, are made at 36 inches, using no extra lenses. This distance is selected to minimize distortion. The range finder can be used for focusing at this distance. The lens opening is set at F-22, shutter speed is 1/25 second, and clear, gas-filled bulbs are used with the diffused side of the flash shield covering the flash attachment.

Next, the sunshade and filter holders with the Portra lenses are pressed into position on the camera, and two similar pictures are made with the lips slightly apart, recording the amount of the teeth that normally shows with the lips at rest. These pictures are made at 20 to 25 inches, and this camera-subject distance must be measured accurately. The range finder is set according to the instruction sheet supplied with the number 1 Portra lenses. No change is made in lens opening or flash assembly.

The final two pictures, a front and a side view with the patient smiling broadly, are made at the same 20 to 25 inch camera-subject distance by using the same procedure.

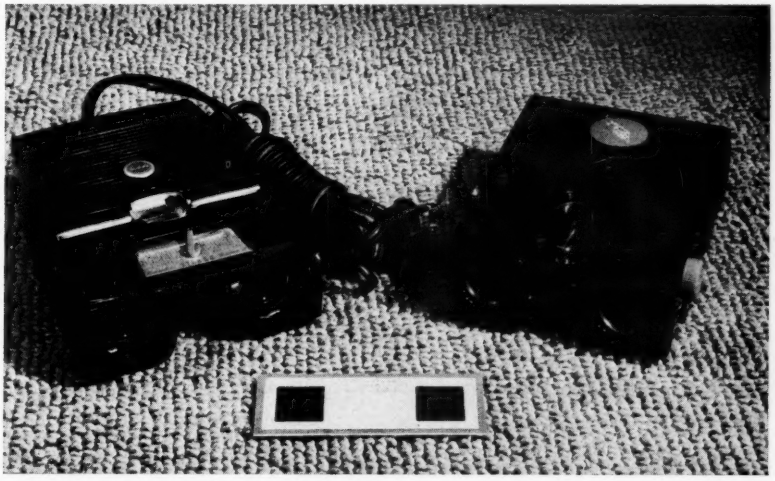


Fig. 3.—Viewers: left, a 110 volt unit, right, a battery operated unit.

VALUE OF THREE-DIMENSIONAL PICTURES

These pictures constitute a permanent record of the appearance of the patient which is vastly superior to all other methods. They are more than pictures as they are actually a series of visual images of the individual.

Such pictures are a valuable aid in checking tooth arrangement and fullness of the face. Thus, the dentist is able to more nearly reproduce the natural appearance of the patient if such reproduction is desired. Furthermore, these pictures furnish an excellent method of checking the alterations in appearance that occur with the passage of years. By furnishing indisputable evidence of unflattering changes, it gives the dentist courage to suggest relining or the need for new dentures.

PATIENT EDUCATION

Valuable as three-dimensional photography can be in helping to achieve and maintain naturalness in denture construction, there remains another area of equal importance where it can be of great value. This is in the field of patient education.

Photographic evidence in the form of the classic "before" and "after" pictures has been used with great success. Their value has been universally recognized. But the same picture taken in "three-dimension" constitutes a much more dramatic method of illustrating what can be done in various circumstances. Their use in this capacity is strongly recommended as a most effective aid in helping to solve the acceptance problem encountered in prosthodontics.

VIEWERS

Close-up three-dimensional slides should not be projected. Therefore, the method of showing slides in the office is by means of a viewer.

There are two main types of viewers (Fig. 3). The illumination for one is furnished by self-contained batteries, and the other plugs into any light socket.

While both viewers are very satisfactory, there is a great advantage in not having to be concerned with batteries. The plug-in viewer has another advantage in that it has a light intensity control which markedly improves "dark" slides, and the "light" slides are improved by decreasing the amount of light.

SUMMARY

There is an ever-present need to emphasize the various steps that can be taken to improve the appearance of dentures. The "impressionistic" and the "realistic" approaches to the solution of this problem have been discussed.

Full credit has been given to the importance of all types of pre-extraction records, but special emphasis has been placed on the use of three-dimensional photography as a very valuable aid. The necessary equipment and a simple effective technique for its use in clinical photography has been described.

Stereographic photography is suggested as a new and exciting means of improving both the quality of denture service and the means by which we make it more easily understood by the patients we serve.

REFERENCES

1. Bliss, C. H.: Psychology as a Factor in the Handling of Denture Patients, J.A.D.A. **28**:1056-1064, 1941.
2. Frush, J. P., and Fisher, R. D.: How Dentogenics Interprets the Personality Factor, J. Pros. Den. **6**:441-449, 1956.
3. Warburton, W. L.: Esthetics in Prosthetics, North-West D. J. **28**:185, 1941.
4. McGee, G. F.: Use of Facial Measurements in Determining Vertical Dimension, J.A.D.A. **35**:342-350, 1947.
5. Pound, E.: Recapturing Esthetic Tooth Position in the Edentulous Patient, J.A.D.A. **55**:181-191, 1957.

812 Frances Bldg.
Sioux City, Iowa

THE USE OF THE FACE-BOW IN MAKING PERMANENT STUDY CASTS

T. D. Foster, B.D.S., F.D.S.R.C.S.
Aylesbury, Bucks, England

Almost 100 years have elapsed since Bonwill introduced his method of constructing dentures on an anatomic basis. He devised a method of mounting casts on the articulator in a definite relationship to the condyle mechanisms. The face-bow has been developed during the last century, and the history of its development has been recorded by Brandrup-Wognsen.[1]

The object of the face-bow is to record the position of the jaws in relation to the condyles. This record is transferred to an anatomic articulator which is intended to imitate the condylar movements in addition to the occlusion of the teeth. Thus, the various excursions of the lower jaw can be observed on casts, and the occlusion of the teeth on the dentures can be tested during construction. In order to do this, the position of the maxillae must be recorded in the sagittal, coronal, and horizontal planes.

Bonwill did not use a face-bow but instead recorded the position of the jaws by a series of measurements. He calculated the average distance between the condyles and the lower incisor teeth and mounted the casts on the articulator using this measurement. However, this method did not take into account the relationship between the lower jaw and the condyles in the horizontal plane but involved consideration of only the coronal and sagittal planes. Furthermore, it was not a direct recording on the patient but a calculation made from a series of measurements.

Later, an attempt was made to calculate a vertical relationship by measuring the angle between the occlusal plane of the lower teeth and a plane from the condyles to the tips of the lower incisors. This was not a direct recording, but it did increase the accuracy of positioning the casts on the articulator.

Various face-bows have been developed to record the position of the jaws directly on the patient rather than using average distances and angles. The face-bow is relatively simple in design and includes the horizontal or Frankfort plane in its recording. The face-bow produced a means of mounting casts on an articulator in their correct relationship to the Frankfort plane and to the position of the mandibular condyles.

THE PURPOSE OF STUDY CASTS

Dental casts are necessary for the construction of a prosthesis and for purposes of study and record.

Received for publication Aug. 29, 1958.

The essentials required for these two purposes are different. *Working casts* must be an accurate reproduction of the parts because the prostheses are made to fit these casts. They may be mounted on an anatomic articulator with the aid of a face-bow to give the best functional value to the prosthesis. However, Craddock and Symmons[2] suggest that the use of a face-bow for this purpose is hardly worth the trouble in view of the small increase in accuracy of positioning obtained.

Fig. 1.

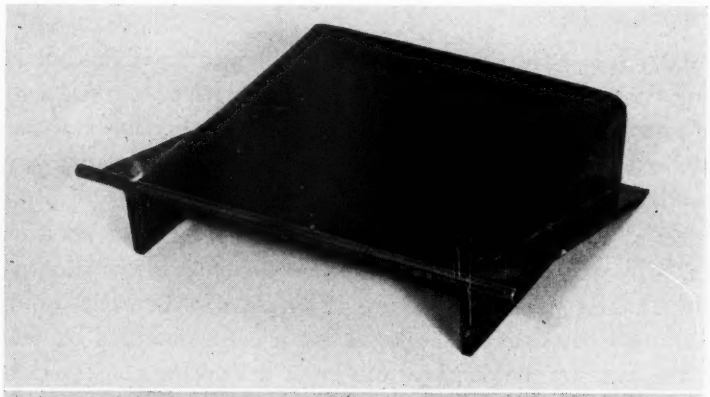


Fig. 2.

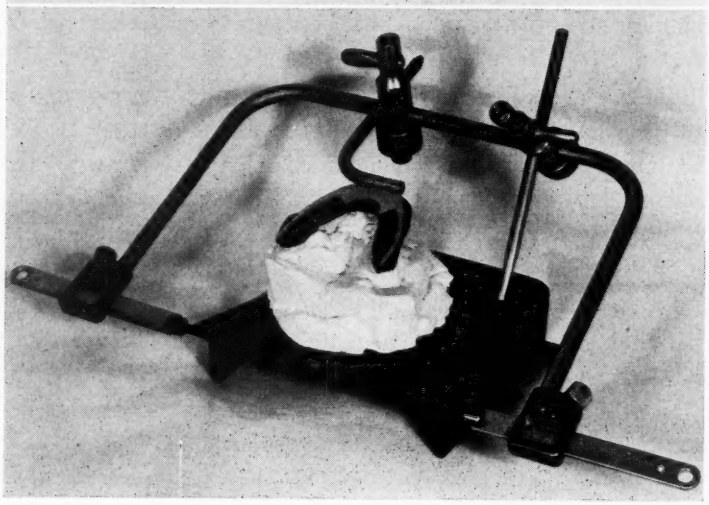


Fig. 1.—A platform is used to mount the upper cast. The horizontal rod fits into the condyle-positioning arms of the face-bow.

Fig. 2.—The upper cast is pushed into soft plaster on the mounting platform.

Study casts fulfill a different need. They are used to demonstrate when the patient's upper and lower jaws are in the correct relationship to each other, as well as certain other details such as the height of the palate and the width of the dental arches. An accurate reproduction of the form of the mouth is necessary, but something more is required of study casts. They should convey a similar impression of the size, shape, and position of the patient's teeth to that which would be seen when examining the patient. Study casts should show the relation of the teeth to the

supporting structures and the facial skeleton as a whole, rather than just the position of the jaws in relation to each other.

Permanent study casts would be of more value if they were mounted so that the teeth were in the correct relationship to the horizontal or Frankfort plane and to the center of the face. More information could be gained from them than if they were mounted arbitrarily.

Study casts may be mounted in the anatomic position by a method which involves the use of a face-bow and a special mounting platform. The face-bow is used to relate the position of the maxillae to the Frankfort plane and to the midline of the face. The use of condylators, as described by Popper,[3] facilitates and expedites the positioning of the face-bow. However, they are not essential, and other methods of determining the position of the condyles may be used.[4]

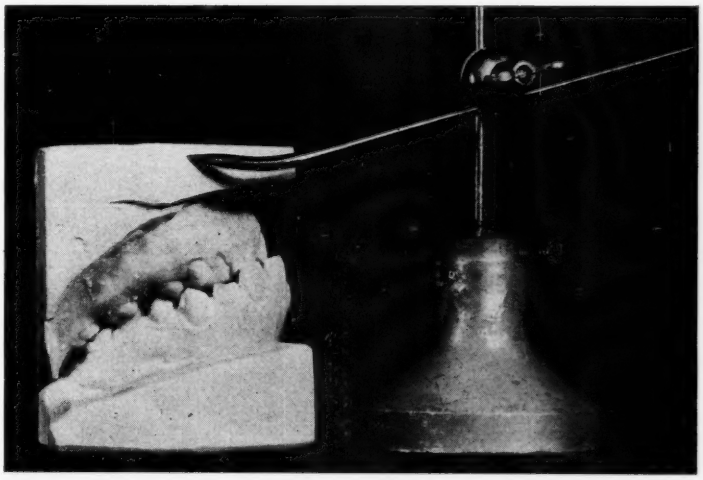


Fig. 3.—The base of the lower cast is marked so that it parallels the base of the upper cast.

A platform is used for mounting the upper cast (Fig. 1). The platform consists of a flat base with a rod fixed at the back on the same level as the base. The rod is of such thickness as to fit easily into the condyle-positioning arms (condyle rods) of the face-bow.

METHOD

A face-bow recording of the patient is made using the orbital indicator to record the position of the inferior border of the orbit. The upper cast, which has an incomplete base, is placed into the wax impression on the fork of the face-bow, and the face-bow is inverted and transferred to the mounting platform (Fig. 2). When the orbital indicator just touches the platform and the condyle markers are in the rod at the back of the platform, the platform corresponds to the level of the Frankfort plane. Plaster of Paris is placed on the platform, and the upper cast on the face-bow is pushed down onto the plaster until the orbital indicator just touches the platform. The base of the upper cast is then parallel to the Frankfort plane. If the

cast is too thick, it can be reduced as long as it is cut parallel to the base thus established.

The lower cast is mounted in occlusion with the upper cast by means of a wax interocclusal record, and the center of the face is marked on the wax interocclusal record. The casts are inverted and placed on a smooth flat surface with the base of the upper cast downward. Then, the base of the lower cast is marked parallel to the flat surface by means of a simple marker (Fig. 3). The base of the lower cast is trimmed to this mark which causes it to be parallel to the base of the upper cast.

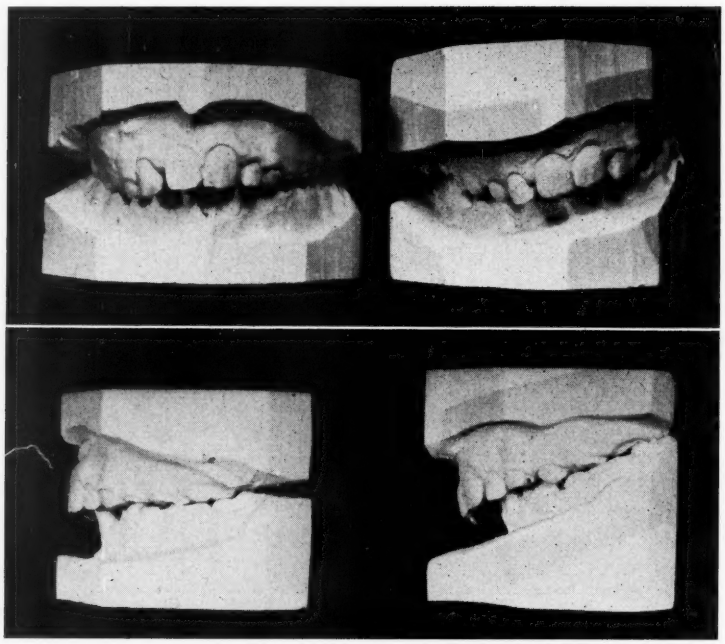


Fig. 4.—Study casts of a patient with a facial deformity that involves the jaws. The casts on the right were mounted in the anatomic position, while those on the left were mounted in an arbitrary fashion.

The sides of the two casts are trimmed vertical to their bases, and the front point is trimmed to correspond with the previously marked center on the wax interocclusal record. Thus, the center of the face is recorded by the casts. The finished casts will stand in the correct relationship to the Frankfort plane.

Study casts may be needed for many patients only to show the position of the teeth in relation to each other and to the teeth in the opposite jaw. It is not necessary to record the position of the jaws in relation to the Frankfort plane for these patients. However, the method described is of particular value when there is a facial deformity involving the jaws. The lateral and vertical asymmetry of the jaws is then permanently recorded by the casts (Fig. 4). Casts mounted in an arbitrary fashion give no indication of existing asymmetry of the jaws, whereas many casts mounted by the method described may show marked asymmetry.

SUMMARY

A method for mounting study casts in the anatomic position using a face-bow and a special mounting platform has been described. Little extra time is needed to mount casts in this way, either in the recording stage or in the mounting stage. A permanent record is obtained which is of more value than that obtained with study casts made in the usual manner.

I wish to acknowledge the help given by Dr. D. Greer Walker and Professor A. O. Chick in the preparation of this article.

REFERENCES

1. Brandrup-Wognsen, T.: The Face-Bow, Its Significance and Application, J. Pros. Den. **3**:618-630, 1953.
2. Craddock, F. W., and Symmons, H. F.: Evaluation of the Face-Bow, J. Pros. Den. **2**:633-642, 1952.
3. Popper, F.: A Simple Face-Bow Technique Describing the Condylator, J.D.A. South Africa **10**:412-413, 1955.
4. Lazzari, J. B.: Application of the Hanau Model "C" Face-Bow, J. Pros. Den. **5**:626-628, 1955.

Stokes Mandeville Hospital
Mandeville Road
Aylesbury, Bucks, England

THE DENTAL ASPECT OF ESTHETICS

OSCAR E. BEDER, B.S., D.D.S.*
The University of Washington, School of Dentistry, Seattle, Wash.

ESTHETICS IS THE SCIENCE or that branch of philosophy which deals with the beautiful. Thus, esthetics is relative, and standards vary. Certain rehabilitative procedures in prosthetic dentistry may influence the esthetic potential of the patient. The dentist may manipulate these procedures to advantage or disadvantage as evaluated by different perspectives such as subjective and objective, and depending upon contemporary taste. Therefore, the theoretic or artistic concept must be modified by the wisdom of experience.

CRITERIA OF ESTHETICS

Pleasing appearance and the faculty to communicate acceptably with society are important criteria of esthetics. There is acceptance of eclectic influences. One must use judgment and rationalize carefully any attempt to create perfection of beauty of one part if the total part lacks comeliness because of ontogeny, natural tendency, accident, or disease. To do so makes the unattractiveness more conspicuous by contrast and thus negates the efforts at improvement. The prosthodontist must attempt to make a denture as inconspicuous as possible so that it blends with the patient's countenance.

HARMONIOUS DIMENSIONAL PROPORTIONS

Harmonious dimensional proportions are necessary within the range of esthetic variation. The cleft lip and palate individual or the dental cripple are excellent examples. There may be a discrepancy in the ratio of the vertical dimension of the middle and lower third of the face due to faulty, or lack of, occlusion (Fig. 1). The chin tends to approach the nose at too great a degree, the profile is poor, and the muscles of the face and jaws function incorrectly at this reduced dimension. When the growth of the dento-alveolar structures fails to keep pace with the vertical growth of the face, a child may compensate for the functional incompetence by thrusting his mandible forward. This magnifies the problem. The corrective procedure is the provision of a stop to the arc of movement of the mandible at a dimension that creates a more pleasant appearance. The stop is formed by increasing the height of the clinical crowns and modifying the occlusal surfaces of the strategic natural teeth or by means of fixed or removable dentures occluding in centric relation (Fig. 2).

Received for publication Oct. 17, 1958.
*Associate Professor, Director of Maxillofacial Prosthesis Clinic.

Some patients expect the dentist to eliminate facial wrinkles with a prosthesis. Although wrinkles produced by loss of facial height and bulk can be minimized by increasing the vertical dimension of occlusion and restoring contour, dentures are not a panacea. Attempts to "push out" wrinkles by means of additional bulk of the flanges will usually result in decreased retention of the denture. Overcontouring of the upper lip by the denture makes the lip and the nose conspicuously unesthetic. In addition, changes in the hard and soft tissues supporting and being supported by the denture will result in a decrement of the esthetic values.

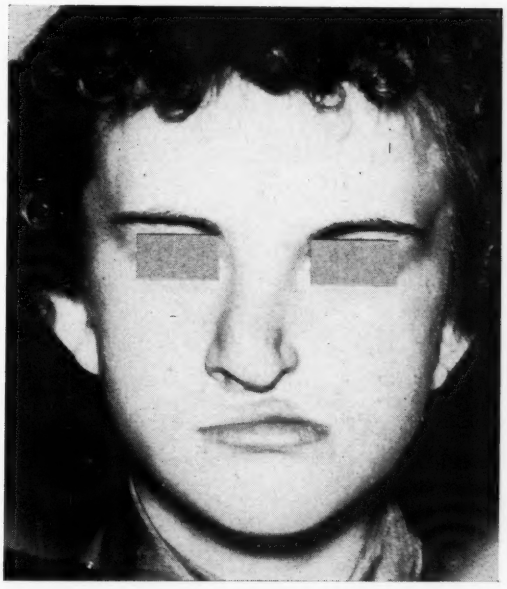
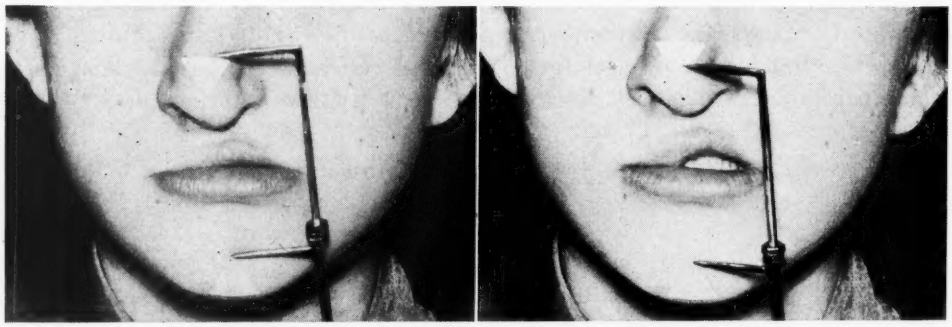


Fig. 1.—The vertical dimension of occlusion is reduced too much.

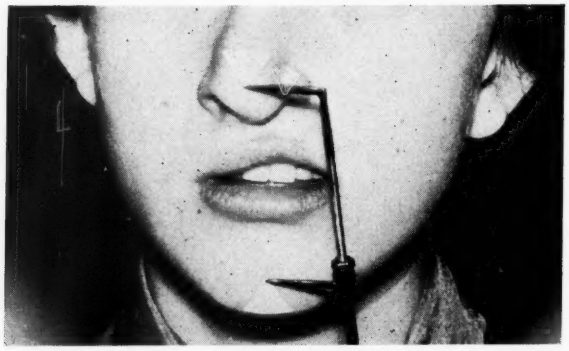
In the edentulous or cleft lip and palate person with a retroposed premaxilla, an obtuse nasolabial angle and thin vermillion area produce an unsatisfactory appearance. Improvement may be attained by plumpers[1] or scaffolding that supraposes the lip and everts the vermillion surface (Fig. 3). Conversely, excessive length of the labial flange or bulk of a denture may cause the lip to be overcontoured or interfere with its normal movement, especially in the area of the frenum. The person with a congenital cleft palate with a retroposed premaxilla but with an acute nasolabial angle due to a depressed nasal tip requires correct bulk and contour of the lip plumper in order to avoid incongruity. Actually, the plumping should be postponed until the nasal tip position is corrected by surgery.

Lip length may be significant occasionally in smiling or talking. For an individual with a long upper lip, retention, stability, and phonetics may require that the maxillary anterior teeth be at a level that does not permit exposure during movements of the lip. This may create the illusion of an edentulous condition. Conversely, with an unusually short upper lip, it may be impossible to avoid ex-

posing most or all of the labial surface of the teeth and sometimes even the denture base itself. This may be a desirable quality to a professional model but may be disliked by a housewife who is burdened with domestic problems.



A. *B.*



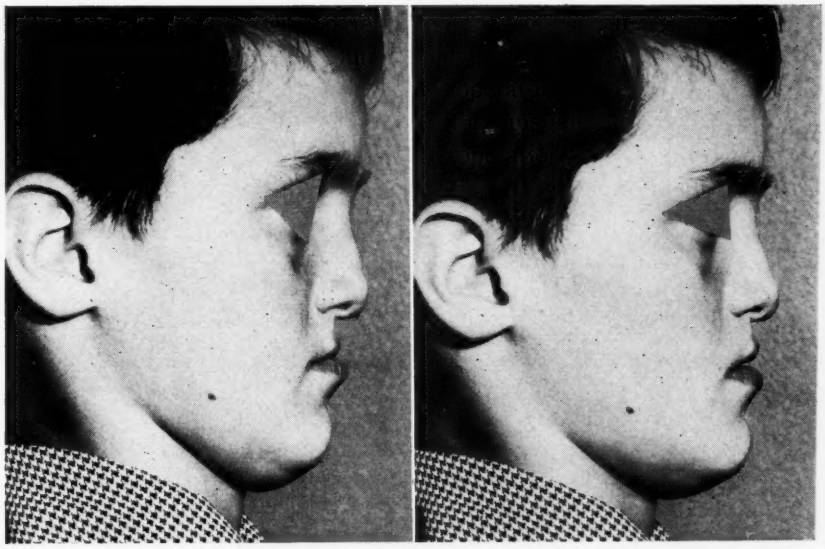
C.

Fig. 2.—A caliper is used to measure the vertical dimension of occlusion. *A*, The teeth are in centric occlusion, and the vertical dimension of occlusion is short. *B*, The patient is in centric occlusion and centric relation. The vertical dimension of occlusion has been increased by a removable partial denture. *C*, The patient is at the vertical dimension of physiologic rest position. Note the interocclusal distance.

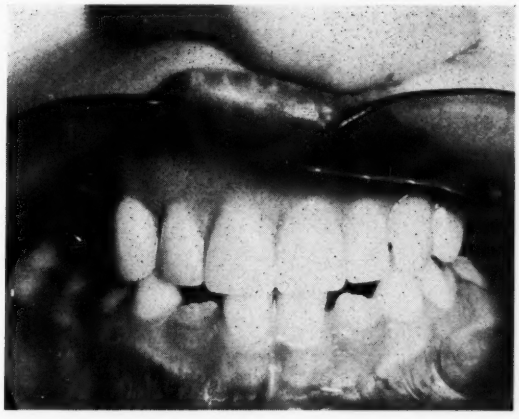
The influence of optical illusions upon dimensions is well known. Thus, increasing the vertical height of a tooth of the same width will make it appear narrower (Fig. 4). Maxillary anterior teeth may give the illusion of being smaller in a person with a wider mouth. Apparent disproportions of the teeth may also occur when faces are unusually wide or narrow. Therefore, different tooth molds (size, outline form, and profile) may be indicated for the same individual at different age levels, coincident with the changes in the face.

The eyes also tend to detect and exaggerate lack of bilateral symmetry. If the contact points between the right and left maxillary central incisors are not in the midsagittal plane, an undesirable effect of distortion is created. A deviated nose tip or philtrum may magnify this condition. Similarly, if the plane formed by the incisal edges of the maxillary anterior teeth is not parallel to a plane drawn be-

tween the center of the pupils of the eyes, an impression is created of lack of uniformity. Nervous habits of raising the lip unilaterally or scar tissue distortion of the traumatized or surgerized lip add to the difficulty.



A. *B.*



C.

Fig. 3.—*A*, A retroposed premaxilla results in a lack of support of the upper lip. *B*, The lip contour is improved by a maxillary removable partial denture serving as a lip plumper. *C*, The denture is in the mouth.

SHADE

The shade[2] of the teeth has a definite bearing upon the appearance of a person (Fig. 5). Shades that are too light may be incompatible with the faces of older individuals, while the darker shades may not suit younger persons. Sometimes vari-

ance in the shade of individual teeth for the same patient has detrimental effects. The reflection and refraction of the light from the teeth effects an unesthetic appearance (especially in the postsurgical cleft lip), and thus is an important consideration in restorative work. A removable partial or complete immediate denture is indicated for many of these patients (Fig. 6).

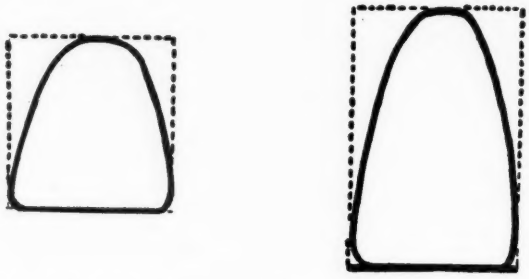


Fig. 4.—Increasing the vertical length of a tooth makes it appear narrower. These outlines are equal in width.

PHONETICS

Esthetics also involves the ability of an individual to communicate in a satisfactory manner.[3] Therefore, dentures should restore satisfactory speech or improve upon nasal speech. An obturator for an acquired palatal defect[4,5] or a speech appliance[6] for a congenital cleft of the palate augment procedures being employed

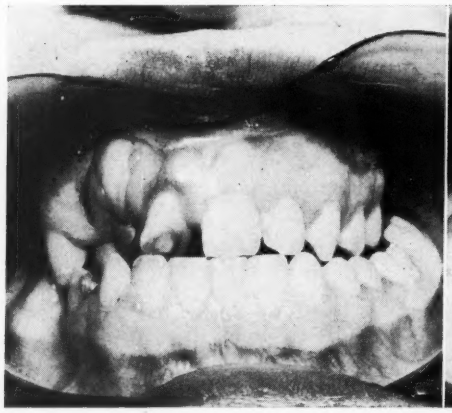


Fig. 5.

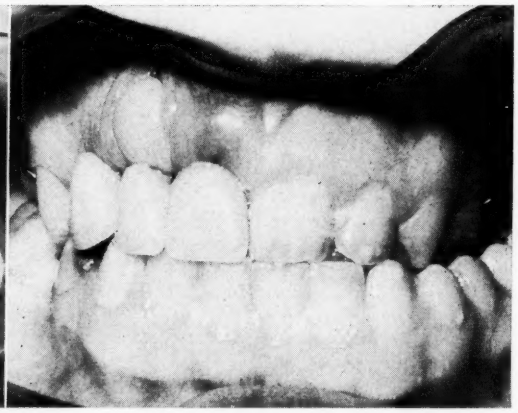


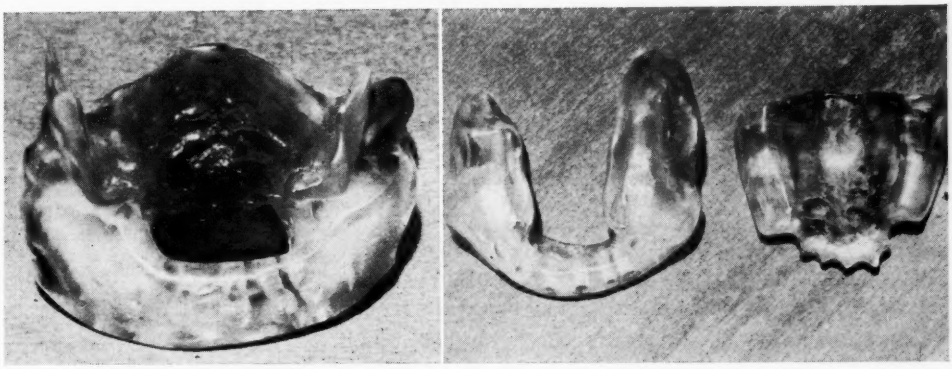
Fig. 6.

Fig. 5.—Discolored teeth are esthetically undesirable.
Fig. 6.—A removable partial denture was inserted immediately after the discolored teeth were removed.

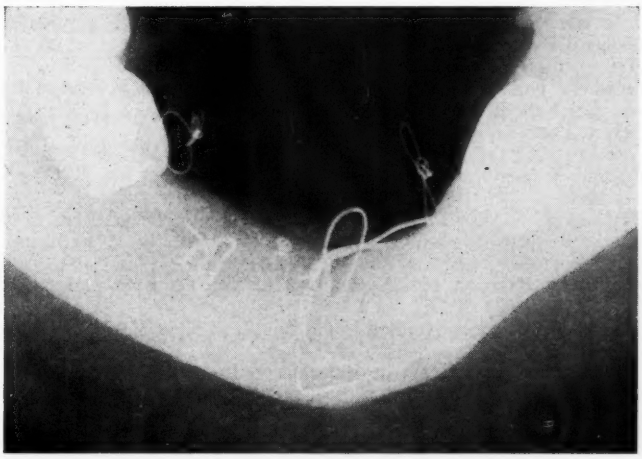
by re-establishing anatomic or physiologic conditions. However, obturators should be used only when surgical judgment prescribes temporary or permanent postponement of correction of the defect with living tissue.[7]

Restoring missing or malposed anterior teeth may present divergent problems in phonetics[8] and retention and stabilization. The edentulous person may have lost

an appreciable bulk of his alveolar ridge. Leverage requires that the mandibular anterior teeth be placed over or close to the crest of the mandibular ridge. This tooth position may create an excessive horizontal overlap between the lingual surface of the maxillary anterior teeth and the labial surface of the mandibular anterior



A. *B.*



C.

Fig. 7.—*A*, A modified Gunning splint is used to stabilize mandibular segments prior to the insertion of a bone graft. *B*, The splint is separated to show the maxillary and mandibular portions with recessed areas for locking. *C*, A roentgenogram of the mandible shows the bone graft.

teeth, and the lower lip collapses with concomitant difficulty in the production of certain sounds.[9,10] It may be necessary to build a "speech roll" on the palate of the maxillary denture lingual to the anterior teeth. The exception to this occurs for the patient who insists upon two sets of dentures, one for esthetics and one for function.

Temporary or permanent restorations[11] can be made for patients with an osteotomized or ostectomized mandible to facilitate techniques employed to improve esthetics and to augment reconstructive procedures. Splints are used sometimes to maintain the segments of the mandibular rami in correct alignment as in the

correction of prognathism or for the insertion of a bone graft[12] (Fig. 7). Removable partial or complete dentures may be required to support a plumper or act as a scaffolding to restore contour. A stent[13] must be used first to re-establish a sulcus in some patients. The prosthesis, however, cannot always restore all of the facial contour lost by the removal of a portion of ramus. Thus, the surgeon must decide whether a surgical, prosthetic, or combined approach is indicated for the patient.

SUMMARY

Esthetics is relative as it is evaluated from various perspectives and under different conditions. The dentist may be able to assist the surgeon in attaining a more satisfactory result for a patient undergoing corrective or reconstructive procedures. However, factors inherent in the dental environment and techniques may exert a limiting influence upon the degree of esthetics gained. Therefore, a team approach to the problem produces the best result.

REFERENCES

1. Beder, O. E., Bruno, S. A., Kaplan, J. I., and Lane, S. L.: Lip Plumpers, Oral Surg., Oral Med. & Oral Path. **5**:1268, 1952.
2. Young, H. A.: Denture Esthetics, J. Pros. Den. **6**:748-755, 1956.
3. Pound, E.: Esthetic Dentures and Their Phonetic Value, J. Pros. Den. **1**:98, 1951.
4. Ackerman, A. J.: Prosthetic Management of Oral and Facial Defects Following Cancer Surgery, J. Pros. Den. **5**:413-432, 1955.
5. Beder, O. E.: Postsurgical Prosthesis, Oral Surg., Oral Med. & Oral Path. **1**:291, 1948.
6. Beder, O. E., and Saporito, L. A.: The Orofacial Cripple, Am. J. Ortho. & Oral Surg. **32**:351, 1946.
7. Lloyd, R., Pruzansky, S., and Subtelny, J. D.: Prosthetic Rehabilitation of a Cleft Palate Patient Subsequent to Multiple Surgical and Prosthetic Failures, J. Pros. Den. **7**:216, 1957.
8. Fymbo, L. H.: The Relation of Malocclusion of the Teeth to Defects of Speech, Arch. Speech **1**:204, 1936.
9. Handbook of Speech Pathology (edited by Travis, L.), New York, 1957, Appleton-Century-Crofts, Inc.
10. Reichenbach, E.: Speech Function in Relation to Loss of Teeth and Artificial Dentures, Quitessenz **7**:25, 1956.
11. Beder, O. E.: Appliances to Correct Resected or Missing Portions of the Mandible, Am. J. Ortho. & Oral Surg. **32**:59, 1946.
12. Converse, J. M., and Campbell, R. M.: Bone Grafts in Surgery of the Face, Surg. Clinics North America **34**:375-401, 1954.
13. Beder, O. E.: The Use of Stents in Skin Grafting in the Mouth, J. Oral Surg. **2**:32, 1944.

School of Dentistry
The University of Washington
Seattle 5, Wash.

EFFECTIVE USE OF DIAGNOSTIC DATA

SAMUEL FRIEDMAN, D.D.S.*
New York University, College of Dentistry, New York, N. Y.

THE MERE LISTING and accumulation of diagnostic information are pointless and of no significance unless the data obtained are carefully correlated, critically evaluated, and intelligently integrated in the plan of treatment.

BASIC FACTORS

Successful resolution of the problem will then hinge upon three cardinal factors: (1) the soundness of the treatment plan, (2) the knowledge, experience, skill, and clinical judgment of the dentist for its successful execution, and (3) the patient's cooperation which must encompass both willingness and capacity to persevere and master the use of well-constructed dentures. The capacity of the patient is a factor of major consideration because under certain conditions willingness alone is inadequate. For example, in the aged, the debilitated, in those with poor neuromuscular control, in patients suffering from Parkinson's disease, in maladjusted menopausal and postmenopausal patients, the capacity to achieve adequate mastery over artificial dentures may be markedly curtailed.

PROCEDURE

In all patients, a complete case history, a thorough extraoral and intraoral clinical evaluation, and roentgenographic and digital examinations should be included in the over-all diagnostic survey.

DIAGNOSIS

Diagnosis can be resolved into a study of four basic factors:

1. *Local Biologic Factors.*—These include the health of the temporomandibular joints, the size and tone of the musculature, the quantity and quality of the saliva, the tissue tone, and the quality of the supporting structures. All of these local factors may be correlated with the patient's general health.

2. *Local Physical Factors.*—These include the size and shape of the ridges, the amount of denture space available, the ridge relations, the nature of the resistant attachments, and their proximity to the ridges.

3. *General Health.*—In the category of poor health can be listed anemic, diabetic, arthritic, aged, and debilitated individuals, and those with tuberculosis, blood dyscrasias, neuromuscular disturbances, and maladjusted menopausal and postmenopausal patients.

Received for publication Sept. 8, 1958; revised by the author May 6, 1959.
*Associate Professor of Denture Prosthesis.

4. *Mental Attitude.*—The mental attitude is often a reflection of the patient's general health. A disturbed, hysterical outlook is frequently encountered in the postmenopausal patient.[1] In this case, the nature of the supporting structures, the friability of the tissues, and the patient's poor health are responsible for innumerable and conflicting complaints. Some of these complaints are without foundation, and the dentist's patience will be taxed to the very limit.

INITIAL MEETING

The examination begins with the initial meeting. As the patient enters, the over-all physical make-up, the gait, the general alertness or sluggishness of the patient comes into view. The patient should be comfortably seated in a consultation room, if one is available, and encouraged to present his history. All pertinent information is carefully noted and recorded. Inquire into the general health, age, diet, and the patient's use of any medication, drugs, or vitamins. If necessary, consult with the patient's physician.

The examination is continued in the dental chair. The making of impressions at this time after a most casual examination should be avoided. This procedure causes subsequent rebases, remakes, innumerable adjustments, complaints, friction, misunderstanding with and loss of patients. The examination proper is divided into extraoral[2] and intraoral phases.

EXTRAORAL EXAMINATION

Face.—Observe the face. Note any deviation from the normal, such as a hemiatrophy, hemihypertrophy, swelling, neoplasm, or mere muscular enlargement. A differential diagnosis must be established. Note any mandibular deflection and consider the prosthesis in the light of subsequent symmetry and anatomic and physiologic harmony.

Neck.—Next look at the neck. A hard, stony swelling in the neck may be the first indication of a possible metastasis from a malignancy in the head and neck. Palpate the parotid, submaxillary, submental, and cervical regions for any evidence of swollen nodes or glands. If present, check the history, symptoms, and signs of pathology. If in doubt, arrange an immediate consultation with the proper authority.

Temporomandibular Joints.—Examine the temporomandibular joints. Are the joints symptomatic or asymptomatic? With your fingers overlying the joints, have the patient open and close. Note any evidence of tenderness, crepitus, clicking, or snapping sounds. If present, recheck the history and consider the advisability of temporomandibular joint roentgenograms. Adequate therapy may call for sedation and hot, wet dressings. In the treatment plan give special consideration to the incorporation of the correct vertical dimension, centric relation, and a harmonious balanced occlusion for the elimination of all centric and eccentric deflective occlusal contacts.[3,]

Lips.—Note any evidence of cracking, fissuring, or ulceration of the lips.[5] A vitamin B complex deficiency and/or loss of vertical dimension are the more common etiologic factors. A consultation with the patient's physician may be desirable. In constructing new dentures for these patients, (1) provide proper support to the

orbicularis oris muscle and lips by correct positioning of the upper anterior teeth anteroposteriorly, (2) widen the anterior part of the arch, (3) increase the occlusal vertical dimension within the limits of the vertical dimension of rest position, (4) thicken the border of the maxillary denture from the cuspid to the second molar region in order to provide better support for the cheeks, and (5) supplement the patient's diet with effective amounts of vitamin B.

Lips vary in contour and length. They may be thick, thin, tense, taut, short, or long, and in combination thereof. In the trial setup check the inclination, slope, and fullness of the lips from the front and sagittal views. There is a greater degree of tooth visibility with a short upper lip. To reduce tooth visibility, set the teeth more nearly vertical and/or raise the anterior part of the occlusal plane. With a long lip, drop the plane and/or position the upper anteriors slightly more forward to show more of the teeth. With thin lips, exercise meticulous care as the slightest anteroposterior deviation may alter the facial expression. Tense, taut lips may be found in highly nervous individuals, in naturally constricted oral orifices, in the presence of scar tissue around the lips, and in atrophy of the lips due to aging. In these cases, set the lower anterior teeth more nearly vertical with their cervical ends closer to the crest of the ridge and/or lingual inclination in conjunction with a reduced labial thickness of the denture base material.

FACIAL MEASUREMENTS

When natural teeth remain and in patients already wearing dentures, facial measurements[6] are useful (Figs. 1-6). These approximate measurements are helpful in the trial setup for comparing the height of the anterior artificial teeth to that of the dentition. The accompanying photographs show the manner of recording these measurements. Where natural teeth remain, record any irregularities, stains, or diastemas for possible reference in constructing the dentures. Immediate dentures should always be recommended unless a specific contraindication exists.

PROFILE PATTERN

An accurate index of lip contours and the relative positioning of the anterior teeth is desirable. A profile pattern can be useful. It can be made by means of a Silhouetter,[7] by contouring a soft lead[8] or copper wire, or by means of a roentgenogram. The facial form[9] can serve as a guide in the arrangement of the anterior teeth.

PHOTOGRAPHS

Photographs[10] of patients having natural or artificial teeth are invaluable for esthetic diagnosis. Take front and profile views in the centric and rest positions, in smiling, and a front view with the lips parted and the teeth in centric occlusion.

INTRAORAL EXAMINATION

Examine the mucosa of the cheeks and lips, the floor of the mouth, the hard and soft palates, tonsillar areas, all surfaces of the tongue, the saliva, and the size and shape of the jaws and ridges.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 1.—An S. S. White-Willis gauge is used to measure the distance from the nose to the lower border of the chin when the teeth are in centric occlusion.

Fig. 2.—The distance from the nose to the incisal edge of an upper central incisor is measured.

Fig. 3.—The distance from the incisal edge of a lower central incisor to the lower border of the chin is measured.

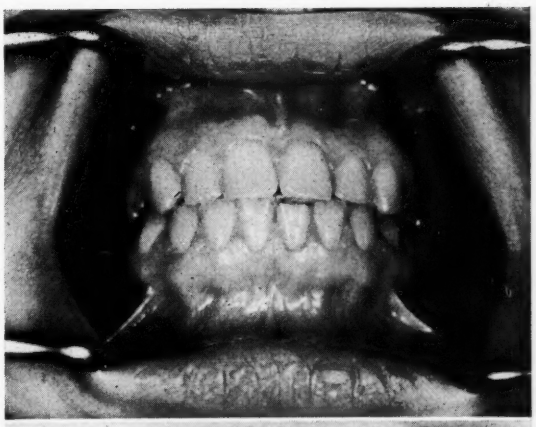


Fig. 4.

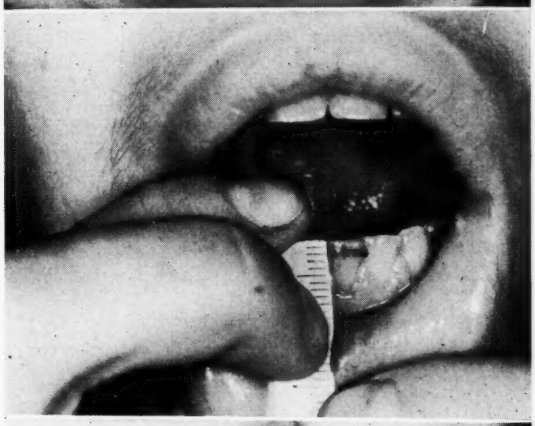


Fig. 5.

Fig. 6.

Fig. 4.—With the teeth in centric occlusion, a pencil mark is drawn across the labial surface of a lower central incisor corresponding to the position of the incisal edge of the overlapping upper central incisor.

Fig. 5.—The distance from the incisal edge of the lower central incisor to the line just drawn across its labial surface is measured with a millimeter ruler. This measurement represents the amount of vertical overlap.

Fig. 6.—The horizontal overlap is measured from the labial surface of the lower central incisor to the labial surface of the overlapping upper central incisor.

Mucosa.—The character of the mucosa will influence the choice of the impression material and technique.[11,12] In the presence of loose, hyperplastic tissue, avoid tissue displacement. Allow the tissue to rest passively within a perforated shellac or acrylic resin tray prior to making the impression, and use a free-flowing material to avoid distortion of the soft tissues. With palatal hyperplasia (Fig. 7), first try to determine the cause. Excessive movement of the patient's dentures, trauma, instability, lack of occlusal balance, allergy, a nutritional disturbance, a vitamin B deficiency, and the presence of the monilial organism may contribute to this condition. Excessive relief, suction devices, commercial denture cleansing creams, and poor hygiene are also irritating factors. According to Thoma and Robinson,[13] the pebblelike papillary hyperplasia may show early carcinomatous changes. The denture-wearing patient may present tissues that are deformed, abused, irritated, and inflamed. Delay the impression making for these patients for several days or longer in order to allow the tissues to recover and assume a more relaxed and normal appearance. The dentures should not be worn during this period. The preservation of the health of the supporting structures calls for the use of a careful impression technique, the correct vertical dimension, an accurate centric relation, and well-balanced, well-adapted dentures. Periodic service, good health, good nutrition, and personal hygiene are equally important.

Tongue.—In examining the tongue, note its general condition and color, size and shape, position and pathology, if any. A smooth, burning, pale tongue may indicate the possibility of a secondary anemia; a beefy red tongue may indicate a nicotinamide deficiency. The fissured tongue may be congenital, but in older patients, consider a possible vitamin B complex deficiency. Also, rule out tuberculosis and syphilis. When constructing dentures for a patient who has been edentulous for some time, avoid crowding the tongue as there may be an initial feeling of inadequate tongue space. The importance of the tongue position[14] as a factor in the patient's ability to master the use of artificial dentures was revealed by Wright and co-workers. In a series of patients studied, it was found that about 25 per cent of them had a so-called clumsy or retracted tongue position. Deviations from the normal tongue position were classified as such. The normal position was defined as that position of the tongue in which it lies lax in the floor of the mouth, occupying practically all of the floor, with the apex resting along the lingual surfaces of the lower anterior teeth and slightly below the incisal edges and with the dorsum of the tongue plainly visible above the occlusal surfaces of the lower posterior teeth when the tongue is in the rest position (Fig. 8).

In constructing dentures for patients with clumsy tongues, allow adequate tongue space. Buccolingually, the lower posterior teeth should not extend lingual to the internal oblique (mylohyoid) line. Keep the occlusal plane low and have the height on both sides uniform. Set the lower first molar 1.0 to 2 mm. below the top of the retromolar pad. Instruct the patient in definite tongue exercises and in eating with dentures.[14]

Check the tongue for pathology. Lesions, if present, must be recognized and differentiated. When necessary, seek consultation.

Jaws.—Observe the size and shape of the jaws. A large jaw generally offers a more favorable prognosis. The jaws and ridges can be classified into three basic

types: square, ovoid, and tapering. The tapering ridge has a minimum horizontal bearing area. It offers the least favorable prognosis and dictates the need for a more critical technique. Observe the amount of denture space between the tuberosity and the retromolar pad. If inadequate, consider surgery and/or the use of acrylic resin teeth. A cast metal base over the tuberosity may be useful.

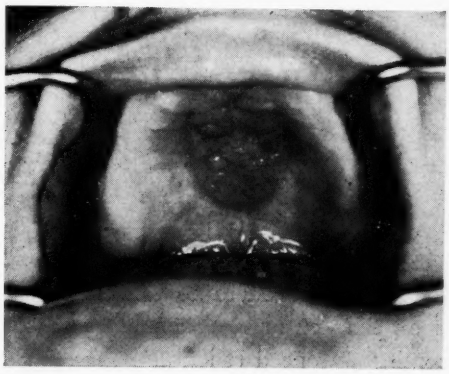


Fig. 7.

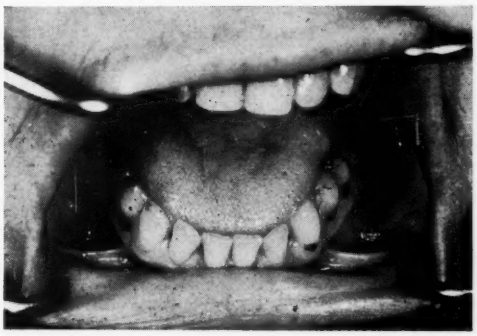


Fig. 8.

Fig. 7.—Extensive palatal hyperplasia conforming to the outline of the relief area in a denture.

Fig. 8.—The normal position of the tongue.

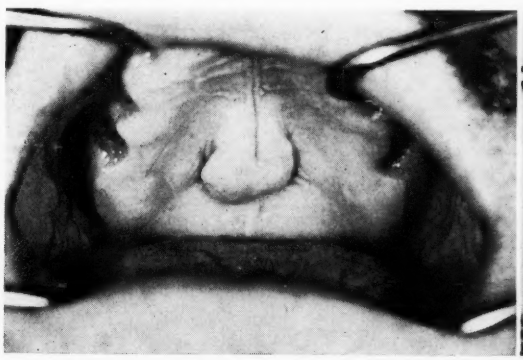


Fig. 9.

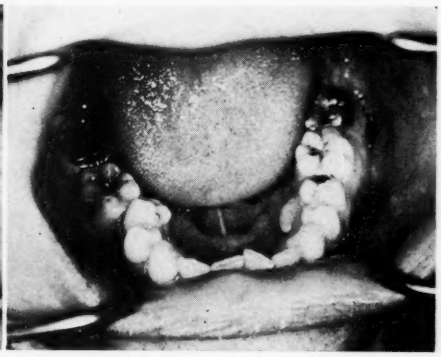


Fig. 10.

Fig. 9.—A low, bulging maxillary torus extending distally beyond the vibrating line. Surgical reduction should be considered if the additional thickness of relief metal might later contribute to the patient's discomfort.

Fig. 10.—A large shelflike mandibular torus in the left premolar region. Surgical reduction prior to the construction of a complete denture is necessary.

At the midline in the upper jaw, note the labial frenum and its proximity to the crest of the ridge. With a low frenum attachment and a high lip line displaying an excessive amount of mucosa, do a frenotomy to eliminate the ugly denture cleavage that will be apparent with the slightest movement of the lips in talking and smiling. Avoid surgery of the buccal frenula in both jaws in order to avoid possible

interference with facial expression. A prominent torus requires relief. When it occurs along with flabby ridges, greater relief is necessary. Consider surgery for a large bulging torus if the additional thickness of relief may otherwise create a cramped, uncomfortable feeling (Fig. 9). If the rugae are hard and the ridges soft, relieve the rugae.

The slightest movement of a denture over a V-shaped palatal vault will break the seal. Develop a good border seal and use an impression material and technique that will cause a minimum of displacement of the thick, resilient soft tissues which generally cover these V-shaped ridges. If a patient exhibits bilateral tuberosity undercuts, remove one undercut only. If diagonally opposing undercuts exist, generally remove the posterior one. Failure to make these corrections will necessitate subsequent relief in the denture, with a possible loss of retention. The making and mounting of diagnostic occlusion rims[15] are helpful in detecting these conditions.

Marked mandibular tori (Fig. 10) or multiple tori should be removed surgically. With average-sized tori, thicken the denture borders to allow for adjustment without producing knife-like edges on the denture. When extreme anterior resorption has occurred, the genial tubercles may need relief, and the lingual border of the denture should be thickened and rounded.

Obscure pain and discomfort in the lower jaw may be due to pressure upon nutrient canals or upon the mental foramen. Relieve the denture, if necessary. With frail, narrow ridges, use narrow teeth (buccolingually) combined with a slight closure of the vertical dimension. Caution patients having a powerful musculature and weak ridges to abstain from extremely tough, coarse foods. Thick denture borders help to control skidding of the dentures. Consider surgical enucleation of extremely flabby retromolar pads.

Saliva.—The quantity and quality of the saliva affects denture comfort and retention. A thick, ropy saliva jeopardizes retention. A high carbohydrate diet may contribute to its formation. An inadequate amount of saliva may contribute to tissue soreness and a dry, glossy mucosa[16] which is most annoying to a denture wearer. Dry mouths may exist in patients with brain tumors, with emotional disturbances, in diabetics, in patients with secondary anemias, nicotinamide deficiencies, allergies, and in the aged due to decreased salivary secretion.

DIGITAL EXAMINATION

For the detection of any sharp edges or spicules of bone that may elude the naked eye, run your finger over the ridges. Surgical reduction, where indicated, will eliminate unnecessary and time-consuming postinsertion adjustments.

ROENTGENOGRAMS

Many dentists fail to make a routine series of dental roentgenograms for all edentulous patients. Twenty-five per cent or more of these patients harbor residual infection, granulomas, cysts, root remnants, impacted teeth, or some form of pathology. The importance of roentgenograms is obvious. For swellings, fractures, and neoplasms, supplemental extraoral roentgenograms are essential.

GAGGING

The cause of gagging may be either tactile or psychic stimulation. In most patients, it is psychic. For gaggers, a careful denture technique, premedication, adequate tongue space, a lower occlusal plane, a stable, well-balanced occlusion, an adequate posterior palatal seal, and the elimination of undue thickness of the dentures are effective countermeasures. Since patients who gag easily require more time in becoming adjusted to dentures, greater patience is necessary in handling them.

SUMMARY

Diagnostic information is invaluable when it is correctly interpreted and effectively used in the treatment plan. A thorough diagnostic service is essential for optimum results. Some patients may present almost insurmountable obstacles by way of extremely unfavorable ridge support, ill health, and/or poor mental attitude. Under these circumstances, satisfaction may be difficult. A thorough knowledge of the subject, an adequate degree of skill and experience, sound clinical judgment, and a maximum effort constitute the dentist's supreme and ultimate resources in coping with and conquering the problems involved in serving the edentulous patient.

REFERENCES

1. Massler, M.: Oral Manifestations During the Female Climacteric (the Postmenopausal Syndrome), Oral Surg., Oral Med. & Oral Path. **4**:1234-1243, 1951.
2. Sarnat, B. G., and Schour, I.: Oral and Facial Cancer, ed. 1, Chicago, 1950, The Year Book Publishers, Inc., p. 41.
3. Friedman, S.: Occlusal Harmony in Complete Artificial Dentures, J.A.D.A. **35**:873-875, 1947.
4. Schuyler, C. H.: The Effect of Abnormalities of Occlusion Upon the Temporomandibular Joint and Associated Structures, Dental Centenary, pp. 303-308, 1940.
5. Kingery, R. H.: Examination and Diagnosis Preliminary to Full Denture Construction, J.A.D.A. **23**:1707-1713, 1936.
6. Dresen, O. M.: Diagnosis, Prognosis and Records Preliminary to the Construction of Dentures, J.A.D.A. **27**:1911-1917, 1940.
7. Nagle, R. J., and Sears, V. H.: Dental Prosthetics: Complete Dentures, ed. 1, St. Louis, 1958, The C. V. Mosby Co., p. 196.
8. Jordan, L. G.: Cooperation of Oral Surgeon and Prosthodontist in Rendering Artificial Denture Service, J. Pros. Den. **2**:55-59, 1952.
9. Hughes, G. A.: Facial Types and Tooth Arrangement, J. Pros. Den. **1**:82-95, 1951.
10. Dresen, O. M.: The Fundamentals of a Complete Denture Technique, New York D. J. **17**:78-88, 1951.
11. Buckley, G. A.: Diagnostic Factors in the Choice of Impression Materials and Methods, J. Pros. Den. **5**:149-161, 1955.
12. Boucher, C. O.: A Critical Analysis of Mid-century Impression Techniques for Full Dentures, J. Pros. Den. **1**:472-491, 1951.
13. Thoma, K. H., and Robinson, H. B.: Oral and Dental Diagnosis, ed. 4, Philadelphia, 1955, W. B. Saunders Co., pp. 323-324.
14. Wright, C. R., Muyskens, J. H., Strong, L. H., Westerman, K. N., Kingery, R. H., and Williams, S. T.: A Study of the Tongue and Its Relation to Denture Stability, J.A.D.A. **39**:269-275, 1949.
15. DeVan, M. M.: Methods of Procedure in a Diagnostic Service to the Edentulous Patient, J.A.D.A. **29**:1981-1990, 1942.
16. Burket, L. W.: Oral Medicine: Diagnosis and Treatment, ed. 2, Philadelphia, 1952, J. B. Lippincott Co., pp. 205-206.

146 East 49th St.
New York 17, N. Y.

THE INFLUENCE OF IMMEDIATE DENTURES ON TISSUE HEALING AND ALVEOLAR RIDGE FORM

ELLSWORTH K. KELLY, COLONEL, DC, USA,* AND RAYMOND F. SIEVERS, D.D.S.**
Washington, D. C., and Bellevue, Wash.

THE IMMEDIATE DENTURE ACTS as a splint for the tissues and promotes healing. The bone resorbs less rapidly and tissue softness is preserved when stimulation is supplied by a denture base.[1,2] No experimental substantiating evidence of these statements exists, but most dentists agree with these observations from the clinical appearance of the alveolar ridges after immediate dentures are inserted.

TEMPLATE TESTS

We formulated a clinical investigation to determine if immediate dentures did exert a beneficial influence on the resulting alveolar ridge. Subjects were available for whom the social advantages of an immediate denture meant very little. We used a clear acrylic resin template and inserted it after the anterior teeth were extracted. After using the template as a guide for the surgery, half of the anterior portion of the template was cut away, and the patient wore it just as he would have had it been an immediate denture (Figs. 1 and 2). This procedure was followed for a number of patients, and 7 of them cooperated sufficiently so that we could use them as a representative group. Observations were made on the second, third, fifth, and seventh postoperative days.

RESULTS

Uniform results were obtained in that on the second and third days the anterior tissue which was confined in the template appeared more rounded and smoother. However, this advantage was lost by the fifth day and thereafter it was impossible to differentiate which side of the ridge had been covered and which side was uncovered (Figs. 3 and 4).

The last patient became very fond of the acyrlic resin template and not only wore it faithfully but used it during mastication to some extent. Her ridge continued to show a difference in the uncovered and covered sides after the fifth postoperative day.

The opinions or assertions contained herein are those of the authors and are not to be construed as official or as reflecting the views of the Army Department or the United States Army at large.

Received for publication Nov. 12, 1958.

*Chief, Dental Service, Walter Reed Army Hospital.
**Formerly Captain, DC, USA.

We concluded that the key to good ridge formation under the influence of immediate dentures was the early functional stimulation that the bases put on the tissue and not the splinting action of the base. In fact, our results showed that there was a benefit from the splinting action but that this benefit decreased after the first postoperative day and was nonexistent after three or four days.

Fig. 1.

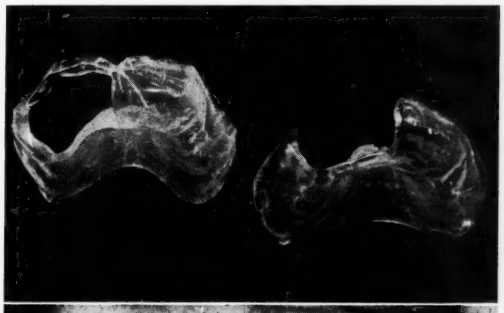


Fig. 2.

Fig. 3.

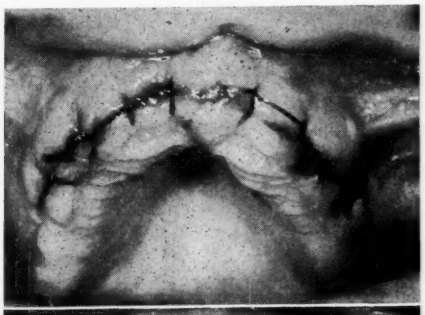


Fig. 4.

Fig. 1.—The transparent templates were cut away in the anterior region. These were placed in the mouth at the time of extraction and worn to simulate the effect of an immediate denture.

Fig. 2.—This template had been in place 5 days after the teeth were extracted. Note that part of the tissue is exposed.

Fig. 3.—A template had been worn for 24 hours. The covered side *(right)* appears smoother where the edematous tissue has been confined.

Fig. 4.—The template has been worn for 5 days. There is little difference in the character of the ridge on either side, and this difference became less apparent within a day or two.

IMMEDIATE DENTURE TESTS

Sometime later we followed this study with the insertion of immediate dentures made on a base such as we had used for the first study. These dentures were made in the usual way, but half of the anterior section was cut away so that half of the anterior ridge was not in contact with the denture base (Figs. 5, 6, and 7). Five patients have been tested in this manner over the past 5 years.

RESULTS

The first few postoperative days showed results such as we obtained when the patients wore the cut-out templates. However, the results of function soon became

apparent. The covered side continued to look more rounded and smoother than the uncovered side, and this difference was apparent until the fifth or sixth week postoperatively. The mucosa appeared more resilient and thicker under the covered

Fig. 5.

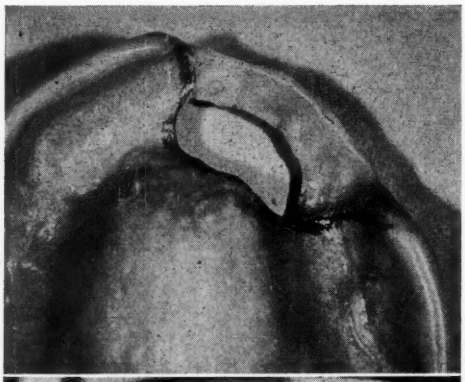


Fig. 6.

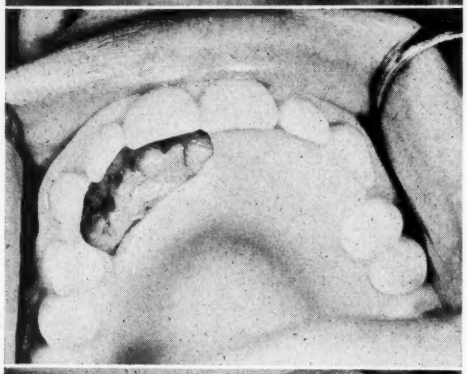


Fig. 7.

Fig. 5.—The extent of contact of the denture base of a test immediate denture with the cut-away portion is outlined in pencil. The thin band of acrylic resin supporting the anterior teeth on the uncovered side was not in contact with the tissue.

Fig. 6.—A test immediate denture is in place in the mouth.

Fig. 7.—The tissue on the uncovered side is not in contact with the denture base material.

side than it did on the side not covered by the denture base (Figs. 8 and 9). The results for all patients were fairly uniform, but it appeared that the difference in ridge formation occurred in direct proportion to the amount of stimulation the

patients gave to the tissues. The patients who adapted quickly to the denture and reported that they were eating everything very early had a greater difference in the covered and uncovered portions than did the patients who adapted poorly and did not do much vigorous chewing during the experimental period. The tests were terminated 5 to 6 weeks after extraction so that comfortable dentures could be constructed for the patients.

Fig. 8.

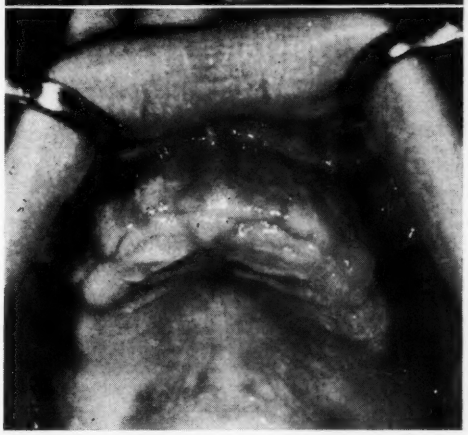


Fig. 9.

Fig. 8.—The covered *(left)* side looks slightly more rounded and smoother 48 hours postoperatively. The templates produce this same effect at this stage of healing.

Fig. 9.—The difference in form between the uncovered and covered sides is quite apparent 30 days postoperatively. The character of the mucosal covering is thick and resilient on the side under function *(left)* and taut and thin over the bony prominences on the uncovered *(right)* side.

SUMMARY

Clinical tests with transparent templates and immediate dentures indicate that:

1. With only the template, the tissue covered appeared smoother and fuller for the first 2 to 3 postoperative days. Thereafter, the difference between the two sides disappeared, although the patients continued to wear the template.

2. With the immediate denture, the good effects of the coverage were prolonged, and after 30 days, distinctly different types of ridges were formed. The results varied among the patients in direct proportion to the function they exerted on the tissue with the denture.

CONCLUSIONS

1. Immediate dentures exert a beneficial splinting action on the tissues by containing the edema and molding the tissues for the first 48 hours postoperatively. After this period, the mere covering of the tissues does no appreciable good.

2. The functional stimulation to the tissues from an immediate denture creates a smoothly-rounded, bony ridge formation and a thick, resilient mucosal covering which would not occur without the stimulation.

REFERENCES

1. Swenson, M. G: Improving Immediate Dentures in General Practice, J.A.D.A. **47**:550, 1953.
2. Hughes, F. C.: Immediate Denture Service: Advantages, Disadvantages and Technical Procedures, J.A.D.A. **34**:20, 1947.

Box 307
WALTER REED HOSPITAL
WASHINGTON 12, D.C.

MUCOSAL EDEMA: A NEW SYNDROME

ROMIE H. MILLER, JR., D.D.S., B.S.D.S.
Clayton, Mo.

COMPLETE DENTURES FAIL sometimes when technical procedures have been executed perfectly. This article explains one reason why patients collect many dentures which they cannot use.[1]

The masticatory apparatus is not a mechanical contrivance to which an accessory, the dentures, must be fitted. A patient is a living, thinking, feeling individual, subject to and responding to stimuli from his internal and external environments.[2] The oral cavity and the dental arches in particular are frequently the scene of such responses which take the form of angioneurotic edema.

Almost every patient is grossly aware of his oral cavity.[3] A visit to the dentist serves to heighten this awareness so that the approach of the impression tray often triggers an immediate, profound response, usually in the form of edema.

Thus, in the construction of complete dentures, the dentist often makes an impression of edematous tissues. Then, when the dentures are complete, the edema subsides and they do not fit. Indeed, they may be grossly ill fitting. This phenomenon is noticeable especially in upper dentures where good retention is taken for granted. The retention of the upper denture may be absent completely and the lower denture may fit as poorly.

Many dentists attempt to rectify the error[4] by relining the dentures. This may improve the fit of the dentures, depending on the amount of edema present, but they are frequently as ill fitting after relining as they were before. So the patient is dismissed and, being dissatisfied, goes elsewhere with the same result.

ETIOLOGY

In order to remedy such a situation one should understand its cause. Mucosal edema of this kind is a conversion symptom, an adaptation of the tissues to a function other than that for which they are primarily intended.[5]

A child's only concern during the first several months of life is the breast or the bottle. His existence is entirely on an oral plane. All is well. When teething begins, the child's state of well-being is upset by the discomfort associated with the eruption of each tooth. When the child is 2 or 3 years of age and still largely in the oral stage of development, cavities form and there are trips to the dentist's office for restorations, if the child is fortunate.

If he is not fortunate, abscesses form and pain develops in his oral cavity. Since the oral cavity is the center of his emotional existence, he may feel a threat

Received for publication Nov. 14, 1958.

to his life or well-being. Now a trip to the dentist culminates in one or more extractions.

At age 6, the first succedaneous molars erupt. Deciduous teeth are exfoliated, and the child is old enough to feel the social stigma associated with missing teeth. The teeth are replaced finally by the eruption of their succedaneous successors and the second molars.

Things are uneventful orally for a few years until the impacted third molars are removed. And so the oral history continues. There are amalgams, inlays, orthodontic appliances, crowns, endodontic therapy, fixed partial dentures, extractions, periodontal treatments, removable partial dentures, and complete dentures. There is halitosis or the fear of it. There is some loss of self-confidence and self-esteem as the teeth are extracted. Fear of old age and death[6,7] is frequently associated with the loss of teeth and with dentures.

From the birth of an individual until his death, his life depends upon the food which he takes into his mouth, masticates, and swallows. His emotional life as well as his metabolism depends largely on the state of his oral cavity. The oral cavity carries with it at all times a large emotional charge.

It is no wonder, then, that the oral cavity is the site of psychogenic responses. How can dentists approach this highly sensitive region with no regard for the emotional attitudes of the patient of whom it is a part?[8]

TREATMENT

Mucosal edema may be overcome or eliminated as a cause for denture failure by one or more of several methods. The patient's attention may be diverted from his mouth by conversationally accenting the impersonal while impressions are made. The dentures may be relined repeatedly and adjusted until an adequate border seal and adaptation to the tissues are achieved. The impressions may be made while the patient is sedated so that psychogenic responses are suppressed. Mucosal edema may be prevented by explaining to the patient exactly what is happening and by the direct suggestion that such responses are unnecessary and undesirable. The same thing may be done by hypnotic suggestion.

SUMMARY AND CONCLUSIONS

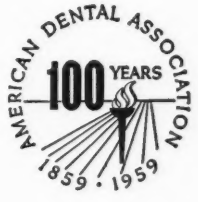
1. The emotional life of every individual is largely oral, regardless of his degree of maturity.
2. The mouth has great emotional significance, and the approach of the dentist often carries with it an unsuspected emotional impact.
3. The success of complete upper and lower dentures may be prevented by psychogenic edema of the alveolar mucous membrane covering the residual ridges.
4. If difficulty in the construction of complete dentures is anticipated, emotional as well as mechanical obstacles should be taken into account.
5. The dentist should be aware of the emotional significance of the loss of natural teeth.
6. Mucosal edema may be controlled by diversion, suggestion, reassurance, sedation, or hypnosis.

7. The dentist must put his own emotional life in order before he can hope to deal successfully with patients who are upset.

REFERENCES

1. Miller, R. H., Jr.: Denture Dynamics, J. Missouri D. A. **36**:16-26, 1956.
2. Miller, R. H., Jr.: Personality Defects and Denture Construction, J. Missouri D. A. **37**:16-20, 1957.
3. Sadler, W. S.: Practice of Psychiatry, St. Louis, 1953, The C. V. Mosby Co., pp. 552-557.
4. Miller, R. H., Jr.: Unsuccessful Dentures and Their Correction, J. Missouri D. A. **37**:8-12, 1957.
5. Weiss, E., and English, O. S.: Psychosomatic Medicine, Philadelphia, 1949, The W. B. Saunders Co., p. 38.
6. Ibid., pp. 725-729.
7. Sadler, W. S.: Practice of Psychiatry, St. Louis, 1953, The C. V. Mosby Co., p. 241.
8. Manhold, J. H., Jr.: Introductory Psychosomatic Dentistry, New York, 1956, Appleton-Century-Crofts, Inc., pp. 145-186.

7734 Maryland Ave.
Clayton 5, Mo.



IMPROVEMENT OF TISSUES FOR THE SUPPORT OF DENTURES

CLAUD M. FRALEIGH, CAPTAIN (DC) USN
U.S. Naval Station, Treasure Island, San Francisco, Calif.

A THOROUGH KNOWLEDGE of the histology and physiology of oral tissues and the application thereof is mandatory for optimum success in the practice of prosthodontics. The success or failure of a prosthetic appliance depends upon many factors. The literature is filled with reports dealing with the mechanical factors involved in the fabrication of prosthetic appliances, but very little is found concerning the histologic factors involved.

Lytle[1] emphasizes the need for permitting tissues that have been abused by ill-fitting dentures to recover and suggests measures for accomplishing tissue recovery prior to correction of the dentures. He states, "Such abnormalities may result either from systemic disturbances or from mechanical factors caused by ill-fitting dentures." It is possible that the histology and physiology of these tissues may be of primary importance in the tissue changes he describes.

Bodecker[2] quoting Pendleton states, "Prosthodontists have long been successful in placing dentures without applying a knowledge of histology to their work." The degree of success for all patients is not evaluated in this report. It is believed that if the reaction of the tissues to the prosthetic appliance can be made physiologic in nature, then the degree of success will be increased. The reaction of the tissues is thought to be due to their inherent histology. Any assistance gained by the application of a knowledge of the histology and physiology of the tissues is of utmost importance in providing a more successful prosthodontic service to patients. If the histology of the tissues is well understood and the physiology of the various types of tissues involved is used to the best advantage, a greater degree of success is assured. This is especially true when these tissues require correction of anatomic defects before a satisfactory prosthesis can be placed.

ANATOMIC DEFECTS

Corrective measures should be instituted when the following anatomic conditions exist: (1) a shallow mucobuccal sulcus, (2) frenum and/or muscle attachments that insert or attach in or near the crest of the residual ridge, and (3) inadequate denture-bearing areas which may be due to (a) an inadequate amount

---

The opinions or assertions contained herein are those of the author and are not to be construed as official or as reflecting the views of the Navy Department or the Naval Service at large.

Received for publication Sept. 26, 1958.

of residual attached gingiva* covering the residual ridge or (b) alveolar mucosa† covering the major portion of the ridge. Both the conditions noted in *a* and *b* above would present the mucogingival junction at or very near the crest of the residual ridge.

It is desirable to have tissues that will afford an optimum denture-bearing base due to its inherent physiologic and histologic characteristics. It is advantageous to have a broad area of dense, well-keratinized tissue to act as the support for the denture and aid in its retention. Where the anatomic defects are present, correction can be made to supply or create a situation that will be conducive to a more satisfactory or physiologic denture service.

When the residual attached gingiva is very narrow and sparse, the denture base must be placed primarily upon movable alveolar mucosa. An extension of the residual attached gingiva was obtained in 23 patients operated upon during the past year. This extension was accomplished by a repositioning of the residual attached gingiva of the residual ridge. This increased the area of tissue that had all of the characteristics (histologically and physiologically) of the residual attached gingiva. The tissue present postoperatively is composed of dense, coarse bundles of collagenous connective tissue covered by a thick, keratinized epithelial layer which is firmly "bound down" or attached to the underlying bone. This provides an excellent denture-supporting tissue. In addition, this tissue will act as a cushion over the underlying bone, protecting it from many of the forces of mastication that will be transmitted through the denture.

HISTOLOGY

Fig. 1 shows the relation of the tissues that must be dealt with in the correction of the listed anatomic defects. The difference between the epithelium covering the attached gingiva and that covering the alveolar mucosa is apparent. Note the direction and alignment of the elastic connective tissue fibers in the tissue apical to the mucogingival line. Their direction and potential to contract are of primary importance in surgical procedures used to extend the residual attached gingiva. Thus, they afford a greater area of denture-supporting tissue. A comparison of tissue with the tooth in place (Fig. 1) with tissue from the residual ridge of an edentulous area (Fig. 2) clearly demonstrates the character of the tissue in each instance.

The periosteum, as defined by Stedman,[4] is the thick, fibrous membrane covering the entire surface of a bone except its articular cartilage. It consists of two layers: an inner one which is osteogenic, forming new bone tissue, and an outer connective-tissue layer conveying the blood vessels and nerve supply to the bone.

---

*Residual attached gingiva is tissue of the residual alveolar ridge that is histologically characterized by heavy, dense bundles of coarse, collagenous connective tissue fibers covered by a heavy, thick layer of keratinized, stratified, squamous epithelium. This tissue is immovable and firmly attached to the periosteum of the underlying bone.[3]

†Alveolar mucosa is tissue of the residual alveolar ridge that is histologically characterized by loose, fine, elastic connective tissue fibers covered by a thin layer of unkeratinized, stratified, squamous epithelium. This thin layer of alveolar mucosa is very movable and is not firmly attached to the periosteum of the underlying bone as is the attached gingiva.[3]

The photomicrograph (Fig. 3) shows the periosteum and its relation to the underlying bone. Note the dense layer of connective tissue adjacent to the bone. Some orthopedists term this inner layer of tissue the "cambium layer." This periosteal layer of tissue is of great importance in our surgical procedures as it is primarily made up of dense bundles of collagenous connective tissue fibers which are firmly "bound down" or attached to the bone. Its osteogenic layer must be retained in a

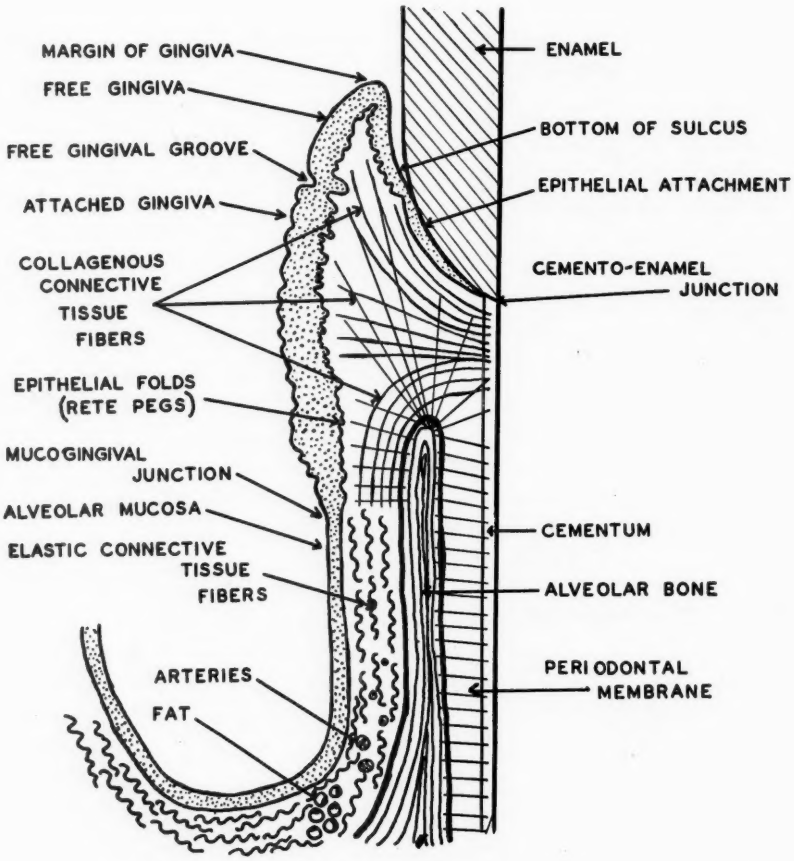


Fig. 1.—Diagram of the attached gingiva and the alveolar mucosa. *Note:* (1) The relative thickness of the epithelium of the attached gingiva and of the epithelium of the alveolar mucosa. (2) The differences in the connective tissue stroma of the attached gingiva and that of the alveolar mucosa. (3) The alignment of the elastic connective tissue fibers in the stroma of the alveolar mucosa and the alignment of the collagenous connective tissue fibers of the attached gingiva.

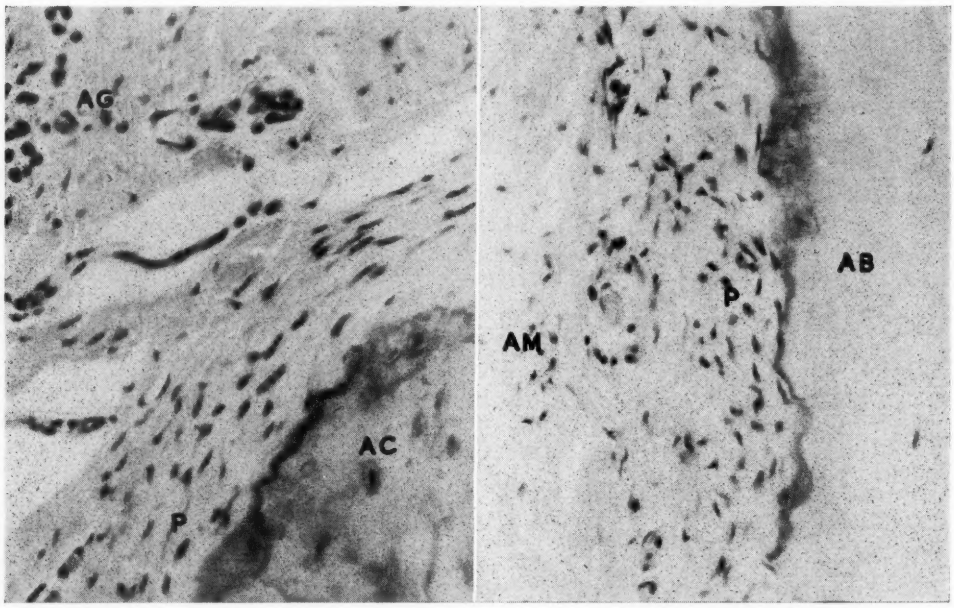
physiologic relation to the bone in any surgical procedure that is used to correct the anatomic defects considered here. The preservation of the "cambium layer" in its physiologic relation to the underlying bone will prevent many postoperative sequella frequently experienced when bone is exposed. When surgical procedures that result in the exposure of bone are used, some sequestration often occurs. Retention of this periosteal layer covering the bone will shorten healing time, greatly

Fig. 2.—Photomicrographs of tissue of the residual soft tissue ridge. The tissue is sectioned at right angles to the residual ridge. *A*, Tissue of the residual attached gingiva showing the heavy bundles of collagenous connective tissue fibers (×100). *B*, High power (×430) of *A*. *C*, Tissue of the alveolar mucosa showing thin, loose, elastic connective tissue fibers (×100). *D*, High power (×430) of *C*.

reduce the postoperative discomfort of the patient, and supply a tissue firmly attached to the bone on which the growth or proliferation of new tissue can take place during the healing of the surgically created wound.

SURGICAL PROCEDURE

The surgical procedure is based upon the histology and physiology of the tissue. This procedure will produce a greater area of acceptable denture-supporting tissue and correct certain anatomic defects at the same time. The initial incision is made



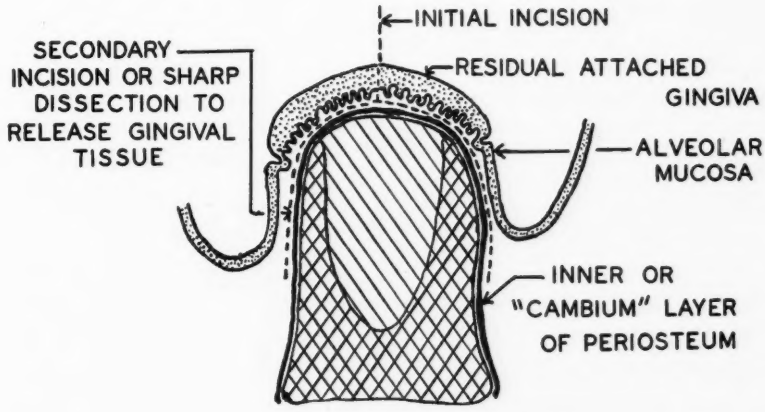
A. *B.*

Fig. 3.—*A*, A photomicrograph of the alveolar crest bone *AC*, periosteum *P*, and the connective tissue fibers of the attached gingiva *AG*. *B*, A photomicrograph of the alveolar bone *AB*, periosteum *P*, and the connective tissue of the stroma of the alveolar mucosa from the level of the mucogingival line *AM*.

through the interdental papilla at time of extraction (Fig. 4). In edentulous areas the initial incision is made in the center or at the height of the residual ridge. In both instances, the incision is made to a depth just short of the underlying bone or down to the periosteal layer. The second incision is the sharp dissection of the overlying soft tissue from the inner periosteal layer which is retained in its position, covering and attached to the bone (Fig. 5). Only the periosteal layer should be left attached to the bone as it is desirable to reposition as much of the elastic connective tissue as possible at a more apical level. This incision allows for the repositioning (Fig. 5) and also deepens the buccal sulcus, thereby giving a greater area that can be covered by the denture. The bone coronal to the repositioned residual attached gingiva (Fig. 5) is covered by the "cambium" or periosteal layer in every aspect except in the alveolar socket. The markedly more apical position of the residual

attached gingiva is easily maintained by the contraction of the elastic connective tissue fibers in the stroma of the alveolar mucosa. These elastic fibers are of assistance in holding this tissue in a static position at a more apical level. Within limits, the deeper or more apical the sharp dissection is made, the more apical will these elastic fibers retain the repositioned tissues in a static position. It is not necessary to manipulate the tissue to the desired optimum extension of the residual attached gingiva or is it necessary to suture this tissue to maintain it in the more apical position.

Fig. 4.


INITIAL INCISION
SECONDARY INCISION OR SHARP DISSECTION TO RELEASE GINGIVAL TISSUE
RESIDUAL ATTACHED GINGIVA
ALVEOLAR MUCOSA
INNER OR "CAMBIUM" LAYER OF PERIOSTEUM

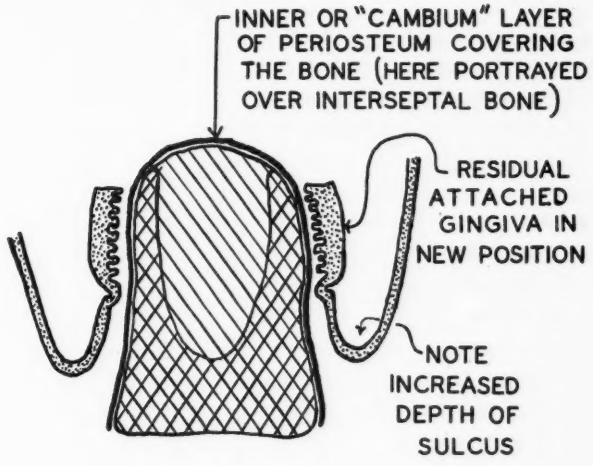

INNER OR "CAMBIUM" LAYER OF PERIOSTEUM COVERING THE BONE (HERE PORTRAYED OVER INTERSEPTAL BONE)
RESIDUAL ATTACHED GINGIVA IN NEW POSITION
NOTE INCREASED DEPTH OF SULCUS

Fig. 5.

Fig. 4.—The surgical procedure for an edentulous area.
Fig. 5.—The surgical procedure accomplished at the time of extraction of a tooth.

Histologic sections (Figs. 2 and 3) reveal the alignment of the collagenous and elastic connective tissue fibers. They also reveal the relative thickness of the epithelial layer covering the connective tissues and the relation of these tissues to

the underlying bone of the residual ridge. The broad expanse of tissue that has all the characteristics of the residual attached gingiva can be seen in the postoperative histologic section (Fig. 2). The repositioning of the residual attached gingiva has an additional advantage in that no scar is created in the tissue that will be in contact with the border of the denture. Scar tissue in this area would greatly reduce the integrity of the border seal of the denture.

Ivancie[5] found that regeneration of gingiva was obtained following a similar surgical procedure used in periodontal therapy. He reported that the alignment or orientation of the collagen fibers, which were covered by a thick keratinized epithelial layer, gave the precise characteristics of normal gingiva. This occurred within a maximum of six months postoperatively. Histologic studies of the tissues preoperatively and postoperatively confirm his findings in this regard. At the end of six weeks, the healing process from a clinical standpoint (Figs. 7 and 9) progressed sufficiently for the fabrication of a prosthetic appliance.

USE OF STENT

The border of the completed denture or that of a denture base with occlusion rims of modeling compound may be used as a surgical stent. A periodontal pack or dressing is added to the border of the stent and used as a dressing over the surgical wound. The periodontal dressing will protect the wound and assist in maintaining the repositioned tissue at its new level. When this procedure is done in edentulous areas for partial dentures, the stent may be constructed of self-polymerizing resin on a preoperative cast. Extension of the border may be obtained by the use of the periodontal dressing. The border may be extended as much as is necessary to retain the tissue at its new level.

USE OF SURGICAL PROCEDURE

Two examples are presented to show the results of this surgical procedure. In the edentulous patient, comparison between the preoperative (Fig. 6) and the postoperative (Fig. 7) illustrations reveal: (1) the increased width of the residual attached gingiva, (2) the more apical position of the mucogingival junction, (3) the absence of scarring in the border seal area, and (4) the increased depth of the buccal sulcus in the postoperative results. The greater area of acceptable denture-supporting tissue is evident in the postoperative results (Fig. 7). Comparable results are shown in the partial denture patient (Figs. 8 and 9). It would appear that the greater expanse of residual attached gingiva would offer better protection to the underlying bone.

SUMMARY AND CONCLUSIONS

The surgical procedure described utilizes the histologic and physiologic characteristics of oral tissues with apparent success since it allows for the preservation and retention of the periosteal layer in its physiologic relation with the bone. It also accelerates healing, affords greater comfort to the patient, and reduces untoward postoperative sequella. Certain anatomic defects can be corrected by this

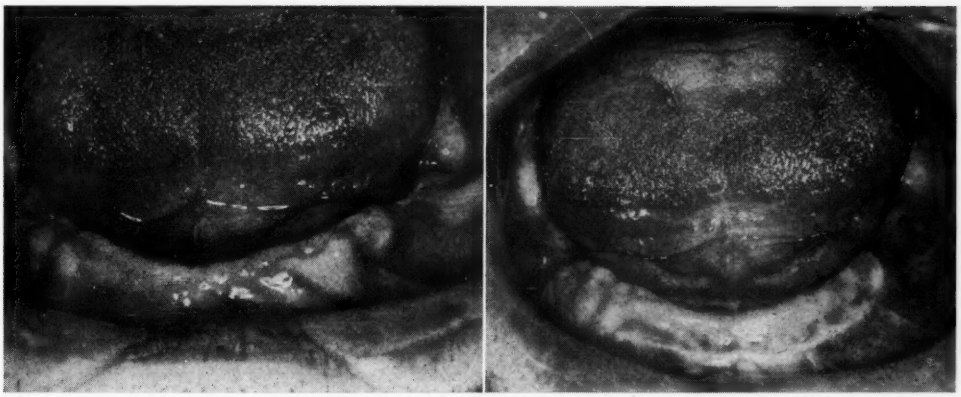
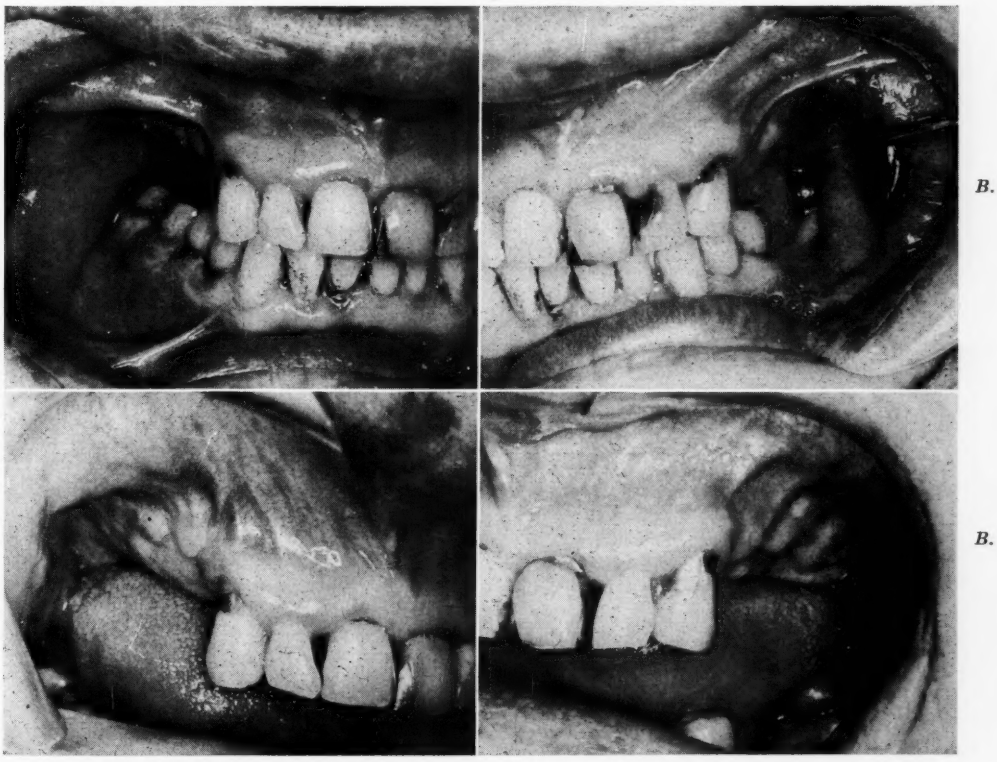


Fig. 6. Fig. 7.

Fig. 6.—Preoperative photograph. Note the attachment of the alveolar mucosal fold into the midline of the residual ridge on the patient's mandibular left side and the almost total lack of residual attached gingiva throughout the residual mandibular ridge.

Fig. 7.—Six-week postoperative photograph of the patient shown in Fig. 6. Note the increased width of the residual attached gingiva and the increased depth of the mucobucccal sulcus.

Fig. 8.



A. *B.*

A. *B.*

Fig. 9.

Fig. 8.—Preoperative photographs showing the tissue attachments on *A*, the right side, and *B*, the left side.

Fig. 9.—Six-week postoperative photographs of the partial denture patient shown in Fig. 8. *A*, Right side. *B*, Left side.

surgical procedure concomitant with the creation of a greater area of acceptable denture-supporting tissue. The resulting extension of the residual attached gingiva will supply an additional cushion between the denture and the underlying bone. This additional cushioning effect should be advantageous in the preservation of the existing residual ridge of bone. Consideration of the histology and physiology of tissues that are to support the denture is of prime importance in attaining satisfactory results in prosthodontic therapy, as it is in all fields of dentistry.

REFERENCES

1. Lytle, R. B.: The Management of Abused Oral Tissues in Complete Denture Construction, J. Pros. Den. **7**:27-42, 1957.
2. Bodecker, C. F.: Histology to Prosthodontia, Article VII, J. Dent. Education **4**:376-387, 1940.
3. Orban, B.: Oral Histology and Embryology, ed. 3, St. Louis, 1953, The C. V. Mosby Co., pp. 220-221.
4. Stedman's Medical Dictionary, ed. 18, Revised, Baltimore, 1953, The Williams & Wilkins Co., p. 1036.
5. Ivancie, G. P.: Experimental and Histological Investigation of Gingival Regeneration in Vestibular Surgery, J. Periodont. **28**:259-263, 1957.

The School of Dentistry
West Virginia University
Morgantown, W. Va.

AN EVALUATION OF DENTURE ADAPTATION ON THE BASIS OF CONTOUR METER RECORDINGS

GUNNAR RYGE, D.D.S., M.S.,* AND CARL W. FAIRHURST, M.S.**
Marquette University, School of Dentistry, Milwaukee, Wis.

THE COMPARISON OF warpage and systematic dimensional changes of dentures has been carried out by numerous investigators during the past several years. Most studies of this type were based upon measurements across the posterior region of dentures or denture blanks.

In 1954, Fairhurst and Ryge[1] concluded that "linear measurements across the posterior of a denture blank are not a true indication of its adaptation." This conclusion was reached on the basis of a large number of measurements, as compared with photographic evidence of adaptation.

Rupp, Dickson, Lawson, and Sweeney,[2] in 1957, approached the problem of determining adaptation by comparing dentures, models, or impressions against a metal master die on a pantographic comparator. Relative differences between two positive or between two negative forms of an object could be obtained by the NBS comparator.

The purpose of this study was to evaluate denture adaptation on the basis of measurements by the Contour Meter described by Ryge and Fairhurst.[3]

PROCEDURE

Test denture blanks were fabricated on improved stone models made in a flexible rubber mold. Alignment balls were positioned in the mold and were transferred to the models. Denture blanks processed on these models received an impression of the alignment balls. Denture blanks were fabricated with:

1. methyl methacrylate gel, using the injection-molding technique and dry heat processing known as the Tilon unidirectional curing process;
2. methyl methacrylate powder and liquid, using the compression-molding technique, and processing in a water bath at 165 degrees for 8 hours;
3. styrene resin, using the injection technique with a preheated resin known as the Jectron process;
4. methyl methacrylate powder and liquid, using compression molding by water pressure from one side and dry heat from the other with the Hydrocast process and equipment.

This investigation was supported in part by Public Health Service Research Grants D-102 and D-860 from the National Institute of Dental Research, U.S. Public Health Service, and by a grant from the Editorial Council of the Journal of Prosthetic Dentistry.

Read before the Dental Materials Group of the International Association for Dental Research, Detroit, Mich., March 21, 1958, and before the Academy of Denture Prosthetics, Detroit, Mich., May 6, 1958.

Received for publication July 7, 1958.

*Professor and Chairman of Department of Dental Materials.

**Instructor and Research Assistant, Department of Dental Materials.

TABLE I. DATA SHEET SHOWING THE METHOD OF EVALUATION OF DIFFERENCES IN COORDINATES BETWEEN MODEL AND DENTURE

DATE 2/28/58
ALIGN. 48.6
TRACING 43.6
INITIALS G.R

SETTINGS FOR MODEL

SETTINGS FOR DENTURE

DENTURE 1 year
T.-2
Date 2/28/58
Align. Pl. 52.3
Tracing Pl. 47.3
INITIALS C.W.F

L		R		L	R	R	L	R		L		L	R
								In Book					
		2.16	2.15		115.50	52.50							
-1.30	-1.27	1.82	1.81	50.50	115.00	53.00	117.50	1.85	1.87	-1.41	-1.39	-.08	.06
-1.57	-1.53	1.68	1.67	51.00	114.50	53.50	117.00	1.66	1.68	-1.61	-1.59	-.06	.01
-1.68	-1.64	1.70	1.69	51.50	114.00	54.00	116.50	1.62	1.64	-1.68	-1.66	+.03	-.05
-1.57	-1.53	1.88	1.87	52.00	113.50	54.50	116.00	1.70	1.72	-1.48	-1.46	+.12	-.15
-1.15	-1.16	—		52.50	113.00	55.00	115.50	—		-1.03	-1.01	+.15	
		12.20	12.19		106.50	61.50		11.95	11.97				-.22
12.15	12.14	12.26	12.25	59.00	106.00	62.00	109.00	12.06	12.08	12.19	12.21	.07	-.17
12.31	12.30	12.27	12.26	59.50	105.50	62.50	108.50	12.10	12.12	12.34	12.36	.06	-.14
12.39	12.37	12.25	12.24	60.00	105.00	63.00	108.00	12.09	12.11	12.39	12.41	.03	-.13
12.39	12.37	12.18	12.17	60.50	104.50	63.50	107.50	12.04	12.06	12.35	12.37	-.01	-.11
12.33	12.32	12.08	12.07	61.00	104.00	64.00	107.00	11.96	11.98	12.28	12.30	-.02	-.09
12.25	12.24	11.98	11.97	61.50	103.50	64.50	106.50	11.86	11.88	12.18	12.20	-.04	-.09
+.01		+.01		83.00	83.00	85.00	85.00	-.02		-.02			

TABLE II. DIFFERENCE VALUES, IN PER CENT, FOR CORRESPONDING MODEL AND DENTURE COORDINATES FALLING WITHIN THE VARIOUS LIMITS OF ACCURACY*

		IMMEDIATE					ONE MONTH				
LIMITS:		±.10	±.15	±.20	±.25	±.40	±.10	±.15	±.20	±.25	±.40
METHODS	T_t	15	30	35	41	65	34	48	58	66	84
	T_s	29	36	45	51	67	29	40	44	55	70
	J	49	60	68	74	83	29	36	59	75	91
	C_t	28	33	38	46	63	36	44	54	64	79
	C_s	34	46	52	65	83	31	43	49	63	80
	V	17	27	37	46	69	20	28	41	50	68

*Average values calculated on the basis of three or more sets of readings.

A total of 64 denture blanks were fabricated, out of which 31 were processed with tin foil as a mold lining material and 33 were processed against a tin-foil substitute. All styrene denture blanks were processed in molds treated with a tin-foil substitute.

Contour Meter recordings were taken immediately after deflasking, after 10 days, 1 month, and 1 year of storage in water at 37° C. In the early part of the study, each recording included 56 corresponding points on each model and denture blank across the same frontal plane. Later, the recordings were limited to include 25 points on each model or denture blank.

Alignment of the models and denture blanks was carried out as described by Ryge and Fairhurst.[3] The lateral coordinate for each point was measured in the frontal plane from the reference ball or indentation located at or near the midline. The vertical or depth coordinate of each point was obtained in a vertical direction from the reference ball or indentation. A sign convention was adopted for the model and denture blank coordinates, such that when a vertical coordinate on a model point was recorded as a positive value, the corresponding denture coordinate was also recorded as a positive value.

RESULTS

Table I shows a data sheet from the latter part of the study and illustrates the method of evaluation of difference in coordinates between the model and the denture. The lateral coordinates are the values under: "Settings for Model" and "Settings for Denture." For each of these settings, a corresponding depth coordinate is read and entered under the corresponding left or right columns. The depth coordinate at the midline reference is subtracted from each of the depth coordinates. These resulting corrected values for the model are subtracted from the denture values to give the variation values on the far right side.

In the early part of the study, the data obtained were evaluated by counting the number of variation values which fell within specified ranges or limits. Such evaluation is exemplified in Table II.

Table II gives the average of variation or difference values for corresponding coordinates which were within the limits indicated at the top of the table. For denture blanks T_t, processed in Tilon in a mold lined with tin foil, 15 per cent of the points recorded immediately after deflasking were found to be within the limits of ±0.10 mm. (±0.004 inch) as compared with the corresponding model coordinates. Thirty per cent of the points were found to be within ±0.15 mm. (±0.006 inch) and so forth. After one month, 34 per cent of the points were within the ±0.10 mm. limit, thus indicating some dimensional change of the denture blanks after storage in water, resulting in improved adaptation. For denture blanks T_s, processed in Tilon in a mold lined with a tin-foil substitute, 29 per cent of the points recorded immediately after deflasking were found to be within the ±0.10 mm. limit and 36 per cent of the points were within the ±0.15 mm. limit. After one month, the figures were 29 and 40 per cent, respectively, indicating very insignificant dimensional changes after storage in water.

PROCESSING TECHNIQUES

By comparing the various materials and processing techniques employed in this study at an adaptation level of ±0.15 mm. the following results are observed:

T_t—Tilon processed in a tin-foil lined mold shows a gain in adaptation from the immediate recording to one month

T_s—Tilon processed in a tin-foil substitute shows a very slight gain in adaptation.

J —Jectron shows a loss of adaptation from the immediate recording to one month.

C_t—Compression molded methyl methacrylate processed in a tin-foil lined mold shows a gain in adaptation from the immediate recording to one month.

C_s—Compression molded methyl methacrylate processed in a tin-foil substitute shows a very slight loss of adaptation.

V —Vulcanite shows an insignificant change in adaptation.

It should be noted that these results are based upon the ±0.15 mm. adaptation level. If different limits are chosen, the results will vary somewhat, as can be ascertained by checking the values listed in Table II.

DISCUSSION

It was noted that a certain number of variation values are of rather large magnitude. These large variations occur as a result of dimensional changes of the denture blanks in a lateral direction, particularly in the flange areas. When a flange moves laterally, recordings at the same lateral coordinate as that used for the recording of the corresponding point on the model will give rise to rather large values of variation, particularly on the inclined surfaces. Consequently, the variation values in these areas are not necessarily an indication of how well a denture blank can be seated on the model or in a patient's mouth. Such evaluation can be obtained from the data by plotting the values on graph paper.

A conclusive evaluation of denture adaptation on the basis of variation values such as those presented here will require correlation with the clinical significance of these variation values and, also, knowledge of the dimensional changes involved in the impression technique. Information of this nature is presently being sought in a long-range clinical study conducted in cooperation with the Veterans Administration Center at Wood, Wisconsin.

In order to further illustrate the relative differences in adaptation of the various denture materials and processing methods, the data obtained by the Contour Meter were subjected to another type of evaluation. In this evaluation, the coordinates for the highest point on each flange and for the deepest point in each ridge area were compared with the corresponding model coordinates. This analysis gave information about dimensional changes both in the lateral direction and in the vertical direction, with the central reference ball as the common zero value in both planes. Comparative values for the various denture materials and methods are given in Fig. 1.

This graph shows representative data from each of the groups of denture blanks. Each bar represents hundredths of a millimeter positive variation of palate from the model or, in other words, it represents the space between the model and the denture.

In general, the adaptation of the dentures immediately after deflasking is poorer than after one month or one year storage. For example, denture T_t, Tilon processed in a tin-foil lined mold, shows a 0.28 mm. space at palate immediately after processing; adaptation becomes better until, after one year, the space is 0.06 mm. Denture C_s, standard compression molding with a tin-foil substitute lined mold, is the only exception to this general trend. Immediately after deflasking, the palate space is 0.19 mm., after one month, 0.22 mm., and after one year, 0.21 mm., which is not significantly different from the value obtained immediately after deflasking.

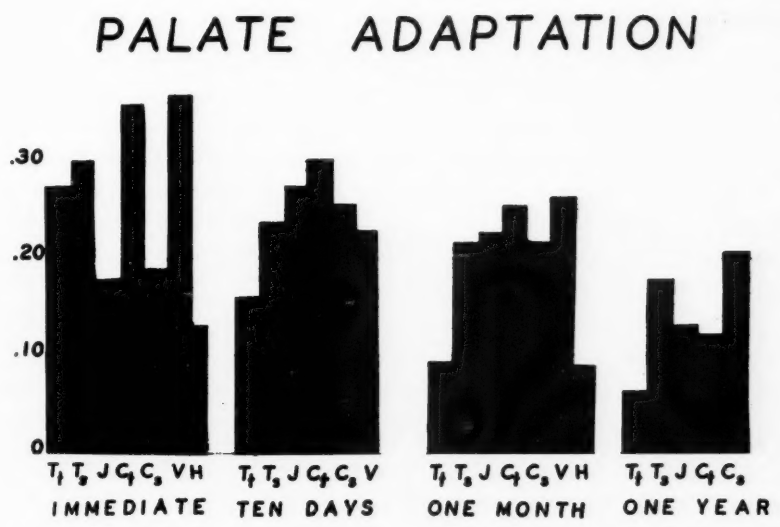


Fig. 1.—Comparison of palate adaptation for various materials and processing methods. The lower the bars, the better the adaptation.

Denture V is a vulcanite denture processed according to a standard technique. This denture shows a palate space of 0.38 mm. immediately, decreasing to 0.27 mm. at one month, which is slightly worse than the poorest resin denture at this time. The Hydrocast denture blanks showed good palate adaptation both immediately after deflasking and after one month's storage. After one year's storage, the acrylic resin dentures processed in tin-foil lined molds show slightly better adaptation than those processed in a tin-foil substitute. Tilon processed in a tin-foil substitute has a 0.18 mm. palate space as compared to 0.06 mm. space when processed in a tin-foil lined mold. In general, there is very little measured difference in palate adaptation of the dentures processed by Hydrocast and Tilon with tin foil, Jectron, or a very well-controlled compression technique with tin foil. It should be emphasized, however, that the newer methods have certain advantages over the compression molding even though these advantages may not be evident in these results.

The compression molding lends itself to considerable abuse, whereas the newer techniques are more critical; one has to follow directions very carefully in order to obtain acceptable results, and this necessity of following instructions very rigidly tends to result in more nearly uniform results. Also, the flasks are better machined, more sturdy, and one has more definite control as far as complete closing is concerned.

Analysis of the data for changes in a lateral direction has not been completed at this time. There is evidence, however, that for most of the procedures studied there occurred a slight change in the position of the flanges in a lateral or outward direction of an order of magnitude of approximately 0.25 mm. More work is indicated to establish possible differences in lateral changes between the methods and materials employed.

CONCLUSIONS

1. Contour Meter recordings can be used to evaluate the relative adaptation of dentures to models.

2. Either method of evaluating the adaptation of dentures will result in a comparative evaluation of techniques or materials. However, the significance of the limits of evaluation must be based upon clinical significance of these limits which is at present undetermined.

3. Work is in progress to establish the clinical significance of denture adaptation.

4. The Hydrocast, Tilon, and Jectron techniques have inherent advantages over the compression molding due to the fact that these newer techniques are well controlled and, thereby, are more likely to result in a uniform end product.

5. Conclusions as to the superiority of any one of these newer methods over the others are not justified on the basis of the results presented in this article.

REFERENCES

1. Fairhurst, C. W., and Ryge, G.: Tin-Foil Substitute: Warpage and Crazing of Acrylic Resin, J. Pros. Den. **4**:274-287, 1954.
2. Rupp., N. W., Dickson, G., Lawson, M. E., Jr,, and Sweeney, W. T.: Method for Measuring the Mucosal Surface Contours of Impressions, Casts and Dentures, J.A.D.A. **54**:24-32, 1957.
3. Ryge, G., and Fairhurst, C. W.: The Contour Meter: An Apparatus for Comparison of Mucosal Surface Contour of Impressions, Models, and Dentures, J. Pros. Den. **9**:676, 1959.

604 N. Sixteenth St.
Milwaukee 3, Wis.

THE ROLE OF EXTEROCEPTORS IN DENTURE RETENTION

N. Brill, L.D.S.,* G. Tryde, L.D.S.,** and S. Schübeler, L.D.S.***
Royal Dental College, Copenhagen, Denmark

Complete denture retention has been discussed extensively in dental literature and from different viewpoints. However, most writers have discussed some physical factor affecting the complex retentive force. From reports containing experimental data, a few will be mentioned because the findings have direct bearing upon this study.

It was shown by Östlund[1] that retention is maximal when the distance between denture and foundation is minimal. It can be inferred from the experiments of Campbell[2] that retention is increased when the fluid film interposed between denture and foundation is of minimal thickness. Moreover, Östlund[3] demonstrated in laboratory experiments that retention might be influenced by the viscosity of saliva. This was confirmed by Körber.[4] He found that the degree of retention is almost directly proportional to the magnitude of the viscosity in the interposed fluid film. Finally, if a denture is flooded, its retention is lowered. According to Dreyer Jørgensen,[16] the retention of a flooded denture is determined only by the rate of salivary influx between denture and foundation.

Although Fish,[5] Matthews,[6] Thourén,[7] Strack,[8] Eisenring,[9] Dorier,[10] Lammie,[11] Stokstad,[12] and others have pointed out that muscle function is important in stabilizing dentures, it seems that no one has singled out this factor in denture retention for experimental investigation.

The normal activity of muscle is dependent upon afferent impulses originating in proprioceptors recording changes in muscles, tendons, and joints. Moreover, they depend upon other afferent impulses originating in exteroceptors, which record changes in the external environment. The touch receptors found in the mucosa of the oral cavity, including those of the tongue, are particularly concerned with denture retention. It is believed that these receptors are of great importance in the precisely adjusted muscular coordination of cheeks, lips, and tongue.

It was observed by Brill[13] that a patient wearing complete dentures lost control of these when surface anesthesia was applied to the mucous membranes. This reaction was ascribed to a "deafferentation" of peripheral receptors brought about by the anesthetizing agent. It was thought practicable to base a further study concerning the importance of muscle activity in denture retention on this observation. The study was limited to complete lower dentures.

Received for publication Sept. 26, 1958.
*Associate Professor, Department of Prosthetic Dentistry.
**Instructor, Department of Prosthetic Dentistry.
***Instructor, Department of Prosthetic Dentistry.
Head: Prof. W. Krogh-Poulsen, L.D.S., Dr.med.dent.

SELECTION OF SUBJECTS

It was assumed that the investigation would be most revealing if the dentures to be studied showed poor physical retention as seen in persons where heavy absorption of bone in denture-bearing areas has taken place.

Therefore, 100 persons known to have "difficult" denture problems were called up for inspection; 28 of these reported. All showed adverse oral conditions ranging from "negative" residual ridges to 3 mm. high "positive" ridges; but for different reasons, 8 persons had to be excluded from the investigation. Since the study was designed to gain insight into the effect of eliminating stimulation of peripheral receptors, persons in whom unsuitable interference from cortex and higher centers could be anticipated could not be accepted. Thus, 2 were rejected after a precedent interview because they showed signs of perplexity and anxiety when told about the experiment. During the experimental procedure when surface anesthesia was applied, 2 more persons were dismissed as they were embarrassed by paresthetic and anesthetic sensations. It was inferred that cortical excitation in these 4 persons would be excessive and would yield values influenced by their mental agitation. Three persons were excluded because of traumatic ulcers in the denture-bearing areas, as it was thought that recordings would be made of reactions to impulses from pain receptors rather than from touch receptors. Finally, 1 person was discharged because insufficient space between the upper and lower residual ridges prevented the making of recordings.

Eventually, 20 suitable subjects were accepted. Their ages ranged from 39 to 72 years, the mean age being 63. They were adequately nourished and in good health. Being told about the experiment, they showed interest, and, although the testing procedure was uncomfortable, their mental attitude remained calm and cooperative throughout.

Apart from severe loss of bone, the oral conditions appeared to be normal as judged by color and texture of the mucous membrane. The tissue tone and thickness of mucosa were estimated to be normal; significant atrophy of the epithelial cover was not detected.

All patients had been treated in the Prosthetic Department at the Royal Dental College, Copenhagen, either by students or by one of the investigators. Their complete upper and lower dentures had been constructed in the period from November, 1957, to June, 1958. Accordingly, they had all had the opportunity of overcoming at least some of the difficulties connected with wearing complete dentures at the time the investigation was made.

The dentures were made from impressions made in accurately adapted individual trays. The impression material used was either zinc oxide and eugenol paste or alginate. According to Skinner, Campbell, and Chung,[14] both materials give equally good results in respect to retention. When the hydrocolloid impression material was used, the "swallowing impression" technique advocated by Hromatka[15] was applied. The dentures were made of acrylic resin which was cured for 9 hours at 75° C. and followed by one hour at 100° C. After curing, the dentures were allowed to cool to room temperature in the boiler for another 9 hours. As all dentures were fitted with narrow teeth and had rather broad fitting surfaces, their polished surfaces converged toward the occlusal surfaces (Fig. 1).

METHOD AND MATERIALS

The forces needed to dislodge a lower denture were measured by means of a spring dynamometer (Correx) provided with a maximum load pointer. Two such instruments were used (Fig. 2), the smaller when the applied load was below 100 Gm. and the larger for values over this amount.

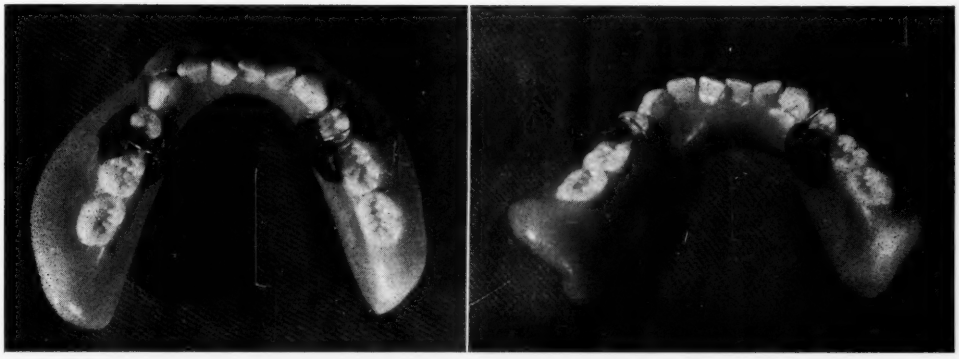


Fig. 1.—Dentures provided with brass wire loops for attaching the dynamometers.

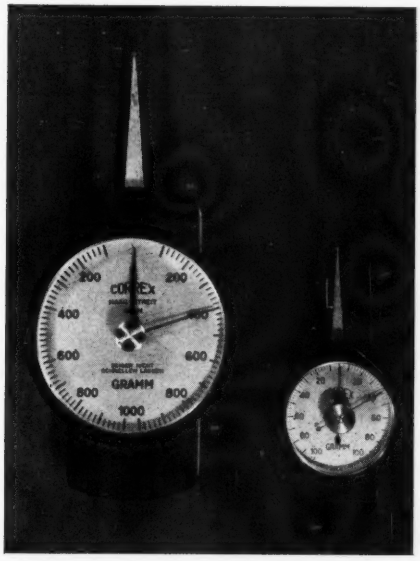


Fig. 2.—Dynamometers employed in measuring forces dislodging dentures.

Two brass wire loops were attached by thermoplastic impression material to the dentures in the embrasures between first molars and second premolars (Fig. 1). The arm of the dynamometer was inserted into one of the loops, and as nearly a vertical pull as possible (i.e., at right angles to the denture foundation) was exerted slowly and steadily until the denture was dislodged. Readings were taken on both right and left sides. The denture was firmly reseated between readings.

Before the actual tests were made, the patients were given a few preliminary trials. The upper denture was removed and the patients were told to relax and allow the mandible (with the lower denture in position) to go into rest position. As far as possible, this position was maintained when recordings were made. The patients were instructed to counteract with cheeks, lips, and tongue any displacing movement of the lower denture they might experience but not do it just because they anticipated a movement.

ANESTHESIA

In the series where anesthesia was employed two different preparations were used, Xylocain jelly and Leostesin ointment. The former is a water-soluble gelatinous substance containing 2 per cent Xylocain. One part was mixed with 9 parts of water in a drinking glass. This volume (200 ml.) was given to each person who was told to take a mouthful and thoroughly turn it over in the mouth and then spit it out. This procedure was repeated until the glass was emptied, and the entire operation generally lasted 5 minutes. The anesthesia obtained was estimated by the patients' description of their sensations. Sometimes the mucosa was pinched with a pair of tweezers.

Usually, however, a reliable anesthesia of sufficient duration was not achieved unless Leostesin ointment was used also. This is an absorbable preparation of 5 per cent Lidocaine. The denture base was covered with a thick layer of this preparation and inserted.

Because the preparation was administered generously, some of it was squeezed out from beneath the denture during insertion and onto the polished surfaces. With two possible exceptions, surface anesthesia of the tissues in contact with the denture was complete in 30 seconds and maintained during the testing period.

Sometimes when Leostesin ointment was applied, a complicating profuse salivation was noted. When it occurred, the patients were instructed to eliminate excessive saliva by spitting; otherwise, flooding would influence the denture retention. The patients were warned against swallowing because of the danger of intoxication; in spite of this, signs of euphoria were observed in one person.

The testing was carried out after proper instructions. Readings were made as pull was exerted on the right side 5 times and on the left side 5 times. Then surface anesthesia was applied and readings were made as pull was exerted on the right side 5 times and on the left side 5 times. This sequence was repeated in each subject and the values were averaged. Accordingly, a total of 400 readings were obtained from the 20 patients.

When the anesthetic ointment was employed, it affected the experimental conditions because the viscosity of the ointment is higher than that of saliva. This change in viscosity might influence denture retention. Therefore, the effect was measured in separate tests in which the vehicle of the preparation was used without its content of anesthetizing agent. Tests and readings were carried out as previously. The data for these series were likewise calculated in averages. This experiment comprised 9 persons and 90 readings.

RESULTS

The series in which no pharmaceutical preparation was used is termed the ÷ series. Similarly, the series employing the vehicle of the ointment is designated

TABLE I. COMPARISON BETWEEN DISPLACING FORCE, MEASURED IN GRAMS, WITHOUT SURFACE ANESTHESIA (÷ SERIES) AND WITH SURFACE ANESTHESIA (++ SERIES)

SUBJECTS	SERIES	RIGHT SIDE				LEFT SIDE			
		M	DIFF.	S	V^2	M	DIFF.	S	V^2
Columns 1	2	3	4	5	6	7	8	9	10
A	÷	568	492^{xxx}	137.0	82.0^{xxx}	948	352^{xxx}	71.5	38.0^{xx}
	++	76		15.0		596		11.6	
B	÷	562	380^{x}	244.1	31.0^{xx}	562	408^{xx}	152.4	28.0^{xx}
	++	182		40.2		154		28.8	
C	÷	364	176^{xxx}	41.0	1.0	352	188^{x}	97.5	34.0^{xx}
	++	188		41.4		164		16.7	
D	÷	600	502^{x}	244.9	272.7^{xxx}	764	648^{xx}	225.0	634.7^{xxx}
	++	98		14.8		116		8.9	
E	÷	642	496^{x}	286.9	1,029.0^{xxx}	862	728^{xxx}	144.3	115.7^{xxx}
	++	146		8.9		134		13.4	
F	÷	1,000	832^{xxx}	0.0	0.0^{xxx}	960	832^{xxx}	89.4	5.3
	++	168		54.0		128		39.0	
G	÷	558	446^{xxx}	91.2	11.6^{x}	568	412^{xxx}	52.6	4.1
	++	112		26.8		156		26.0	
H	÷	352	291^{xx}	127.5	91.5^{xxx}	77	32^{xx}	12.0	1.8
	++	61		13.3		45		8.9	
I	÷	242	166^{xxx}	41.9	4.8	198	70^{x}	39.6	1.0
	++	76		19.1		128		40.4	
J	÷	463	372^{xxx}	54.2	1.1	192	158^{xxx}	18.2	1.0
	++	91		51.3		34		18.6	
K	÷	434	382^{xxx}	99.9	283.1^{xxx}	526	484^{xxx}	109.8	4,392.7^{xxx}
	++	52		5.9		42		1.6	
L	÷	140	102^{xx}	36.7	1,800.0^{xxx}	174	128^{xx}	43.3	10.6^{x}
	++	38		0.8		46		13.3	
M	÷	828	714^{xxx}	122.1	13.2^{x}	872	768^{xxx}	151.4	764.0^{xxx}
	++	114		33.6		104		5.5	
N	÷	468	344^{x}	189.5	128.3^{xxx}	548	412^{x}	198.4	57.9^{xx}
	++	124		16.7		136		26.1	
O	÷	750	286	218.1	7.0	910	534^{xx}	173.6	2.3
	++	464		82.6		376		115.4	
P	÷	214	÷56	45.7	3.6	133	÷87^{x}	12.5	0.1^{x}
	++	270		24.0		220		42.5	
Q	÷	904	16	131.4	0.7	688	38	142.3	4.3
	++	888		159.1		650		68.5	
R	÷	394	326^{xxx}	82.9	53.5^{xx}	500	415^{xxx}	75.1	69.1^{xx}
	++	68		11.3		85		9.0	
S	÷	213	97^{xx}	35.6	29.9^{xx}	200	68^{xx}	25.5	7.9
	++	116		6.5		132		9.1	
T	÷	314	108	81.7	1.0	422	156^{x}	97.7	3.6
	++	206		81.7		266		51.7	

Critical ratio = 38.0^{xxx}.

the + series. The term ++ refers to the series in which surface anesthesia was established. The significance of various values is marked ^{x}, ^{xx}, and ^{xxx} to indicate the 5 per cent, 1 per cent, and 0.1 per cent levels (Table I).

The average values of the ÷ series and the ++ series are given in Table I, columns 3 and 7; their differences are found in columns 4 and 8; the standard deviation of the 5 readings is entered in columns 5 and 9; the ratio between the variances is entered in columns 6 and 10. Similar entries are made in Table II. The significance of each difference is evaluated by the critical ratio as found by dividing the difference by its mean standard error. In calculating a critical ratio comprising all differences we get C.R. = 38.0^{xxx}.

The data show that a conspicuous decrease in denture retention follows the application of surface anesthesia.

Average values for the + series are presented in Table II, columns 3 and 7, for easy comparison with corresponding figures from the ÷ series of the same persons. It is found that a significant increase in retention is recorded in the + series: C.R. = 3.6^{xxx}.

TABLE II. COMPARISON BETWEEN DISPLACING FORCES, MEASURED IN GRAMS, WITHOUT PREPARATION (÷ SERIES) AND WITH THE VEHICLE OF THE OINTMENT (+ SERIES)

SUBJECTS	SERIES	RIGHT SIDE				LEFT SIDE			
		M	DIFF.	S	V^2	M	DIFF.	S	V^2
Columns 1	2	3	4	5	6	7	8	9	10
E	÷	642	242	286.9	2.4	862	106	144.3	22.6^{x}
	+	884		183.5		968		30.3	
G	÷	558	÷12	91.2	0.7	568	42	52.6	0.7
	+	546		113.0		610		64.4	
J	÷	463	÷11	54.2	0.3	192	135	18.2	0.03^{xx}
	+	452		107.3		327		111.0	
K	÷	434	132^{xxx}	99.9	2.6	526	÷58	109.8	1.4
	+	566		62.2		468		94.4	
M	÷	828	24	122.1	0.6	872	92	151.4	9.2
	+	852		159.1		964		49.8	
N	÷	468	290^{x}	189.5	4.5	548	176	198.4	9.1
	+	758		89.5		724		65.8	
O	÷	750	168	218.1	1.4	910	÷84	173.6	0.9
	+	918		183.3		826		183.8	
R	÷	394	58	82.9	3.2	500	14	75.1	0.4
	+	452		46.0		514		122.4	
S	÷	213	÷10	35.6	0.2	200	63	25.5	0.3
	+	203		76.4		137		48.1	

Critical ratio = 3.6^{xxx}.

DISCUSSION

The average retentive force measured in the ÷ series varies considerably in different individuals. Concerning these variations, stress must be placed upon (1) the ability in any one person to exert muscle power, (2) his capacity for learning purposive muscle movements, and (3) varying oral conditions.

No effort was made to correlate ridge height and retention. The general impression was that no significance would be found in this investigation comprising only selected persons showing minor variations in the form of residual ridges.

When horizontal pressure was applied on the buccal surfaces of second premolars and first molars, the dentures could easily withstand pressures of over 1,000 Gm. before they were dislodged, provided they rested on 2 to 3 mm. high ridges. Further comment on this observation will not be made because determination of ridge height was not accurately measured and because the observation was made only on a few of the subjects.

The values concerning subject F deserve special comment. Dislodging forces above 1,000 Gm. were applied in the ÷ series but could not be read because the dynamometer would not record higher values. The figures concerning subjects P and Q seem to show that surface anesthesia was ineffective.

If mucous membranes in the oral cavity are anesthetized, their receptor organs are impeded in giving rise to impulses regulating purposive muscle activity; that is to say that in this experiment the muscles were prevented from stabilizing the dentures. Therefore, it is suggested that in the ++ series, where a chemical "deafferentation" is effected, the dentures depend for their retention mainly on physical phenomena such as gravity, rate of saliva inflow, and viscosity of the fluid interposed between denture and foundation.

In the + series, recorded in Table II, a significant increase in retention takes place when the vehicle of the ointment is applied. This is what should be expected, mainly because the increase can be attributed to a raise in viscosity of the interposed fluid film. On this assumption these results confirm the findings of Östlund[3] and Körber.[4]

This effect should be kept in mind when data from the ++ series are compared with data from the ÷ series. However, when this increase is taken into account, the comparison shows that when muscles counteract a pull on a lower denture, their contribution to retention is greater than the combined effect of other retaining factors.

The results obtained in this study may offer a solution to the question why some dentures seem to serve their purpose well in spite of apparently poor retention, which they do in some cases.

CONCLUSIONS AND SUMMARY

This investigation supports the concept that exteroceptors of the oral mucous membrane are concerned with the purposive behavior of the muscles of cheeks, lips, and tongue.

The experimental data show that muscles have an appreciable effect on denture retention. Using the method described, it is possible to compare the effect of the muscles about the mouth with the effect of other retaining forces; from a comparison, we may even venture upon the conclusion that muscle activity transcends in importance all other factors responsible for denture retention, at least in those cases where the bony foundation of a lower denture is greatly resorbed.

REFERENCES

1. Östlund, S. G.: Some Physical Principles in the Retention of Dentures, Northwest. Univ. Bull. **48**:11-20, 1948.

2. Campbell, R. L.: Some Clinical Observations Regarding the Role of the Fluid Film in the Retention of Dentures, J.A.D.A. **48**:58-63, 1954.
3. Östlund, S. G.: Palatine Glands and Mucin Factors Influencing the Retention of Complete Dentures, Odont. Tskr. **62**:7-128, 1953.
4. Körber, E.: Diskussionsbeitrag, Deutsche. Zahnärztl. Ztschr. **11**:802-810, 1956.
5. Fish, E. W.: An Analysis of the Stabilising Factors in Full Denture Construction, Brit. D. J. **52**:559-570, 1931.
6. Matthews, E.: Some Physical Aspects of Retention, Brit. D. J. **56**:237-239, 1934.
7. Thourén, G.: Om krafter och metoder vid och för helprotesens fixering, Odont. Tskr. **51**:234-287, 1943.
8. Strack, R.: Ueber den Halt der unteren Totalprothese durch Muskelwirkungen, Deutsche Zahnärztl. Ztschr. **1**:85-97, 1946.
9. Eisenring, R.: Die Rand- und Flächengestaltung totaler unterer Prothesen, Schweiz. Mschr. Zahnheilk. **61**:705-717, 1951.
10. Dorier, M.: Le problème de la prothése totale vu par un praticien, Schweiz. Mschr. Zahnheilk. **64**:1138-1173, 1954.
11. Lammie, G. A.: Aging Changes and the Complete Lower Denture, J. Pros. Den. **6**:450-464, 1956.
12. Stokstad, E. H.: Helprotesens form og utbygging, Norsk Tannlaegefor. Tid. **68**:1-9, 1958.
13. Brill, N.: Reflexes, Registrations, and Prosthetic Therapy, J. Pros. Den. **7**:341-360, 1957.
14. Skinner, E. W., Campbell, R. L., and Chung, P.: A Clinical Study of the Forces Required to Dislodge Maxillary Denture Bases of Various Designs, J.A.D.A. **47**:671-680, 1953.
15. Hromatka, A.: Die Methode des Schluckabdruckes zur funktionellen Unterkieferabformung, Schweiz. Mschr. Zahnheilk. **65**:160-162, 1955.
16. Dreyer Jørgensen, K.: Personal communication, 1958.

Universitetsparken 4,
Copenhagen Ø, Denmark

A STUDY OF VERTICAL AND CENTRIC RELATIONS BY MEANS OF CRANIAL ROENTGENOLOGY

T. A. BODINE, D.D.S.
Akron, Ohio

AFTER THE NATURAL TEETH are lost, it is difficult to restore the true maxillomandibular relationship in both the horizontal and vertical planes. In many patients there is no record of the conditions existing before extraction. In other patients due to premature loss of some of the teeth and subsequent malocclusion, the maxillomandibular relationship is incorrect and constitutes a contributing factor in the loss of the remaining teeth.

The vertical relationship of the mandible to the maxillae is a very controversial subject in complete denture prosthesis. Some of the methods employed are: measurements based upon averages taken from numerous patients, pre-extraction records when available, measurements taken from anatomic landmarks on the face, anatomic landmarks in the mouth, phonetics, gnathodynamics, rest postion, and facial appearance.

Orthodontics, through the use of cephalometrics, has contributed much to our knowledge by its investigations into cranial morphology and muscle physiology.

Many dentists rely upon rest position to determine the vertical dimension of occlusion. Inasmuch as teeth are not in contact in rest position, this position becomes a nonfunctional position as far as mastication is concerned. Physiologically, rest and function are separated.

It has been observed that patients with dentitions have various differences between the vertical dimension of rest position and the vertical dimension of occlusion. These differences vary anywhere from 3 to 7 mm. and sometimes more, depending upon the amount of vertical overlap of the anterior teeth.

Cranial cephalometrics was able to enlighten us upon rest position of the mandible, muscle physiology, and bone growth and development of the face, but *not* upon the position of centric occlusion.

After making a study of cephalometrics as used in orthodontics, we started experimentation to see if cranial cephalometrics would help us in this prosthetic problem. Using a cephalometer of our own design, we took head roentgenograms, routinely, of all patients presenting themselves for treatment in our office. The results of these efforts were discouraging when they were analyzed by orthodontic methods. It just did not seem possible to find any consistent anatomic relation between the mandible and the maxillae on edentulous patients by this method.

METHOD AND MATERIAL

Two-hundred edentulous patients were selected. Some were patients for whom we had previously constructed dentures and some were new patients. On

Read before the Academy of Denture Prosthetics at Miami Beach, Fla., April 13, 1954.
Received for publication June 10, 1954; revised by the author March 25, 1959.

the new patients, border molded impressions were made using tray compound and carboeugenol paste or zinc oxide and eugenol paste. Casts were poured and separated. The casts were duplicated and waxed up for making trial bases, invested in flasks, and packed with cold-cure acrylic resin to assure well-fitting bases. These trial bases were finished and polished, and on the lower, an occlusion rim was built and checked in the mouth. Then an occlusion rim was built upon the upper base at the height of the presumed vertical dimension.

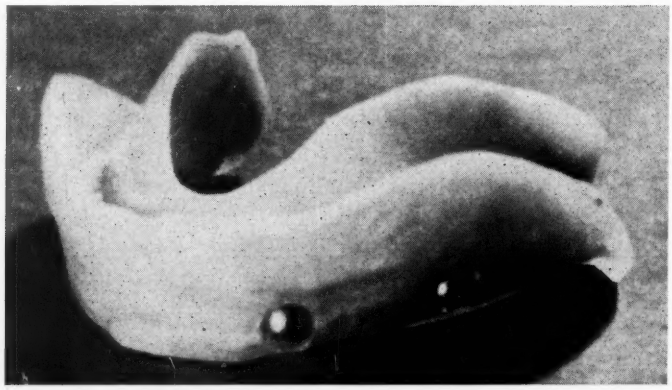


Fig. 1.—Steel ball bearings are positioned in the lower occlusion rims to provide reference points on roentgenograms.

Upon the suggestion of Suchard,* two steel ball bearings ⅛ inch in diameter were imbedded on the right side of the lower occlusion rim (Fig. 1). Centric relation was recorded in our usual manner. The lower base and occlusion rim were placed in the mouth with denture adhesive, and the patient was placed in the cephalometer. The head was secured with the Frankfort plane parallel to the floor (Figs. 2 and 3). Rods in the ears and a plastic support at the nasion were used. When the patient had his mouth closed and in presumed centric relation, an exposure of 2 seconds was made on an 8 by 10 x-ray film. The upper base with its occlusion rim was then removed from the mouth. Water was introduced into the mouth with a water syringe. The patient was instructed to swallow, and another 2 second exposure was made during the swallowing act. The two films were developed and dried. The first film showed the ball bearings in the position of the presumed centric relation (Fig. 4), and the second film showed in the swallowing act that a path of movement had been flashed on the film by the ball bearings (Fig. 5). The first roentgenogram made with the upper and lower occlusion rims present in the mouth was traced, drawing the cranial outline, the sella turcica, the orbit, the nasal spine, the basal bone of the maxillae, the pterygomaxillary fissure, and the mandible. This roentgenogram was removed, and the tracing was matched to the cranial structures on the second roentgenogram which

*Suchard, E. P., orthodontist, associated with Bolton Broadbent Foundation, 1945-1951, 2nd National Bldg., Akron, Ohio.

was made while the mandible was in motion. The top rise of the ball bearing flash was then drawn on the tracing, orienting the position of movement of the steel balls. The roentgenogram was removed from the tracing, and the original roentgenogram was matched to the tracing orienting it to the ball bearings which were drawn from the roentgenogram made while the mandible was in motion. The mandible was traced in its new position. There were now two outlines of the mandible on the tracing. A line was then drawn from the middle of the sella

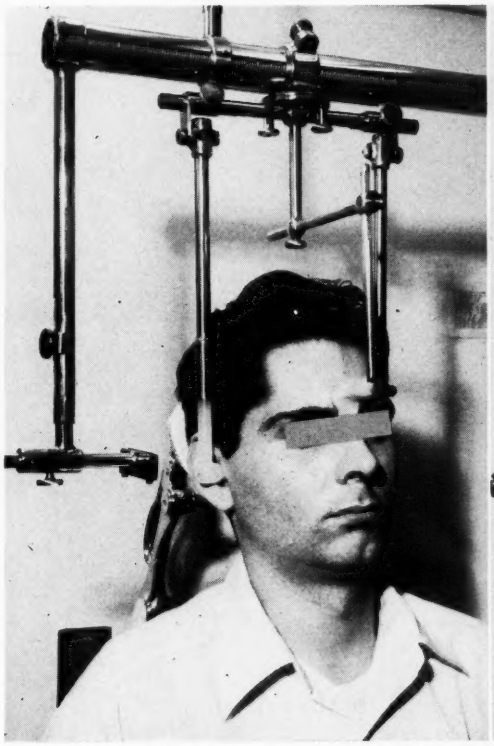


Fig. 2.

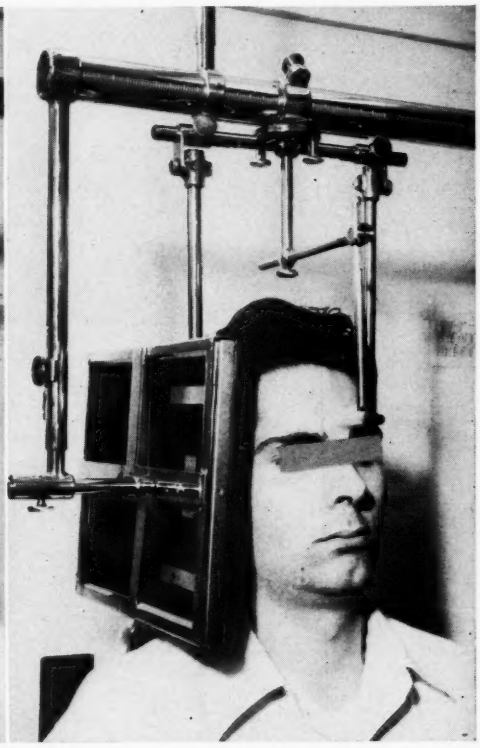


Fig. 3.

Fig. 2.—The patient's head is fixed in the cephalometer for making the roentgenogram.
Fig. 3.—The cassette is in position.

turcica to the nasion. Two lines were drawn from the nasion to the gnathion, one for each tracing of the mandible. Two other lines were drawn from the gonial angle to the gnathion, one for each tracing of the mandible. A line was then drawn from the center of the sella turcica to the gnathion on the corrected mandibular position. The line from the center of the nasion to the gnathion is the facial plane. The line from the gonion to the gnathion is the mandibular plane. The line from the sella turcica to the gnathion is the "Y" axis. The length of both facial planes between the nasion and the gnathion was measured, recorded, and their distances compared. The difference in these measurements is either how much too far open or closed the recorded centric relation in the mouth was dependent upon the new

Fig. 4.

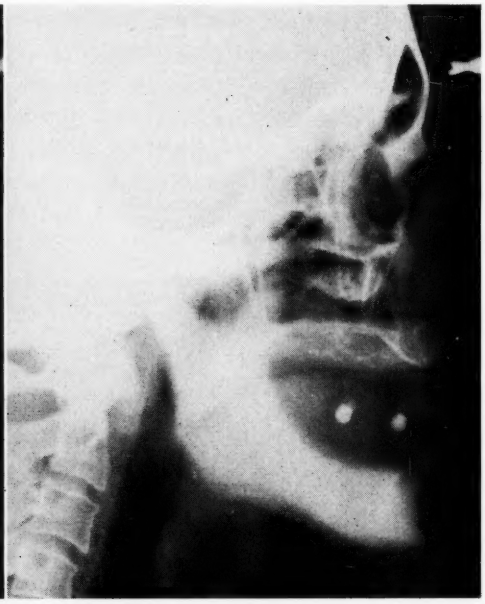


Fig. 5.

Fig. 4.—The upper and lower occlusion rims are in occlusion in the mouth at a tentative vertical dimension of occlusion.

Fig. 5.—The upper occlusion rim has been removed. Note the movement of the ball bearings imbedded in the occlusion rim during deglutition.

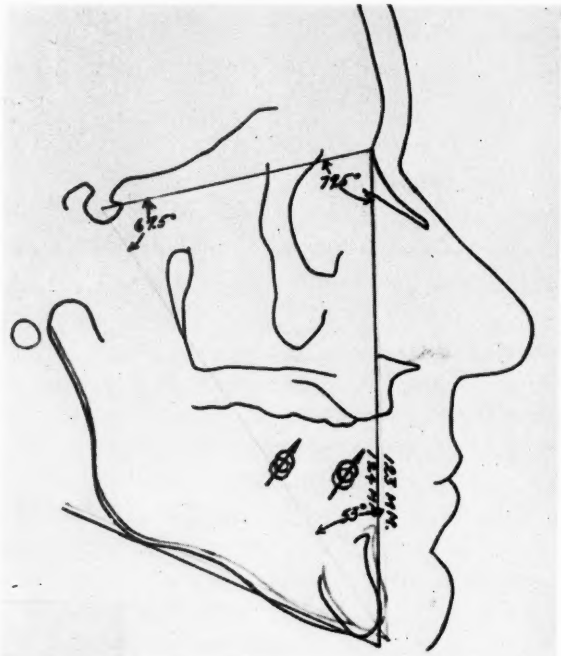


Fig. 6.—A composite cephalometric tracing showing a tentative vertical dimension of occlusion and the change of the positions of the steel balls during deglutition after the upper occlusion rim has been removed. In this tracing the vertical correction is 1 mm. too far open.

mandibular position. The angles between the cranial base plane and the "Y" axis, between the cranial base plane and the facial plane, and between the facial plane and the "Y" axis were measured with a protractor. These degrees were recorded in their respective position on the tracings (Fig. 6).

RESULTS

The following observations were made: (1) During the act of swallowing with no tactile contact, the hyoid bone moved upward and forward (Fig. 7). (2) When occlusion rims were present in the mouth at a tentative vertical dimension, the hyoid bone moved upward but not forward (Fig. 8). (3) There was a change

Fig. 7.

Fig. 8.

Fig. 7.—The movement of the hyoid bone is upward and forward during deglutition when no occlusion rims are in the mouth.

Fig. 8.—The movement of the hyoid bone is upward but not forward when occlusion rims are present in the mouth with too great a vertical dimension of occlusion.

of the position of the steel balls on the roentgenogram from that of the registered centric relation in 9 out of 10 patients. (4) In some cases the positions of the steel balls as shown on the roentgenograms indicated a mandibular position open from the established vertical dimension. (5) In some cases they indicated a mandibular position closed from the established vertical dimension. (6) In some cases they were posterior to the recorded centric relation and either on the same vertical level or above or below the established vertical dimension.

CONCLUSIONS

1. Due to impulses initiated within the encephalon and modified by proprioceptor nerves in locomotor structures, it is almost impossible to obtain a true centric relation record when there is tactile contact between occlusion rims.

2. The problem of centric relation is physiologic rather than mechanical.

3. Each patient is an individual and follows a bone growth pattern initiated by familial and hereditary factors, and, therefore, average measurements cannot be used except as tentative guides.

4. Cranial cephalometrics applied to denture prosthesis provides a basis for a better understanding of physiologic function.

5. The use of cranial roentgenology has a place in prosthetic dentistry.

More study should be devoted to the physiologic factors than has been done. Up until the time the denture bases are placed upon an articulator, the problems are in diagnosis and treatment. It is only after the articulator stage has been reached that they become chiefly mechanical. The requirement for biologic engineering in conformity with the diagnosis of the existing conditions found in each individual patient should not be overlooked.

1207 Akron S & L Bldg.
Akron 8, Ohio

THE TRANSVERSE HINGE AXIS: REAL OR IMAGINARY

LAWRENCE A. WEINBERG, A.B., D.D.S.
Brooklyn, N. Y.

MUCH LITERATURE has been published on the transverse hinge axis and the schools of thought about its relation to articulators. The average dentist, who has no specialized interest in these mechanical principles, finds much confusion among the leaders of this phase of dentistry.

The proponents of Gnathology[1,2] say that there is one transverse hinge axis common to both condyles which can be so accurately located as to justify their permanent tattooing. The proponents of Transographics[3] claim that each condyle has a different transverse hinge axis and that the Transograph is the only instrument that can duplicate this. Still others claim that an *exact* duplication of jaw movement is not possible on any machine and that it would be better to use an articulator, such as the Hanau, that utilizes a face-bow mounting and an average of several readings for excursive movements.

For fixed partial dentures, many feel that a nonadjustable articulator is sufficient, and this eliminates the hinge axis problem altogether. Experiments[4] have shown that even if we believe in the physiologic location of the transverse hinge axis, it cannot be located repeatedly with the pin-point accuracy required to justify tattooing. Others[5] have shown evidence that teeth do not meet in eccentric contact in mastication; the implication could be drawn that harmonious eccentric contact is overemphasized.

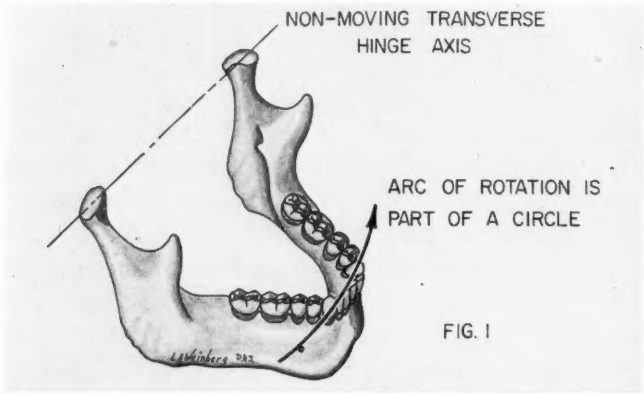
The purposes of this article are to: (1) describe a hinge axis, (2) describe geometric and clinical methods for finding it, (3) describe its use, (4) determine whether there are one or two transverse hinge axes, (5) discuss the mandibular motion pattern for the opening and closing movements, (6) give clinical evidence of the transverse hinge axis, (7) determine if pin-point accuracy in the location of the transverse hinge axis is necessary, and (8) relate these factors to clinical practice.

DESCRIPTION OF THE TRANSVERSE HINGE AXIS

Any three-dimensional object that moves in a coordinated rotational path of motion which is part of a circle or ellipse has an axis of rotation (hinge axis). If the path of motion of the object is part of a circle, the axis of rotation itself is not moving. Fig. 1 illustrates the transverse hinge axis of the mandible which is the center of its circular motion. Clinically, the patient would be described as closing "on a hinge" which is usually a trained motion used for recording purposes.

Received for publication Aug. 11, 1958.

If the path of motion of the object is part of an ellipse, the transverse hinge axis itself must move. Clinically, the condyles would be translating as the patient opened the jaw (Fig. 2). The path of motion of either type of movement



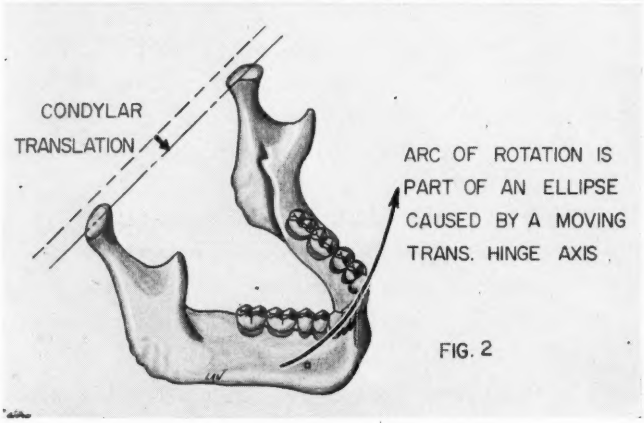


Fig. 1.—A three-dimensional object that moves in a coordinated rotational path of motion, which is part of a circle, has a nonmoving axis of rotation (hinge axis).

Fig. 2.—An object that moves in a path of motion that is part of an ellipse has a transverse hinge axis that itself is moving.

must be perpendicular to the transverse hinge axis by definition whether the hinge axis moves or not. A door, for example, must swing in an arc perpendicular to a line through the hinges.

Fig. 3.—The transverse hinge axis can be located geometrically by erecting perpendiculars that bisect two or more secants of the circular path. The transverse hinge axis is always perpendicular to the arc of rotation.

Fig. 4.—The transverse hinge axis is located clinically by means of a clutch and assembly which is attached to the mandibular teeth.

Fig. 5.—The condylar path for a moving transverse hinge axis is shown with several hinge axis locations on that path. The arc of rotation corresponding to each transverse hinge axis location is shown at the incisors. The incisor movement is shown arbitrarily to be five times the hinge axis movement. When these points of each arc of rotation at the incisors are joined, the line represents the path of mandibular opening.

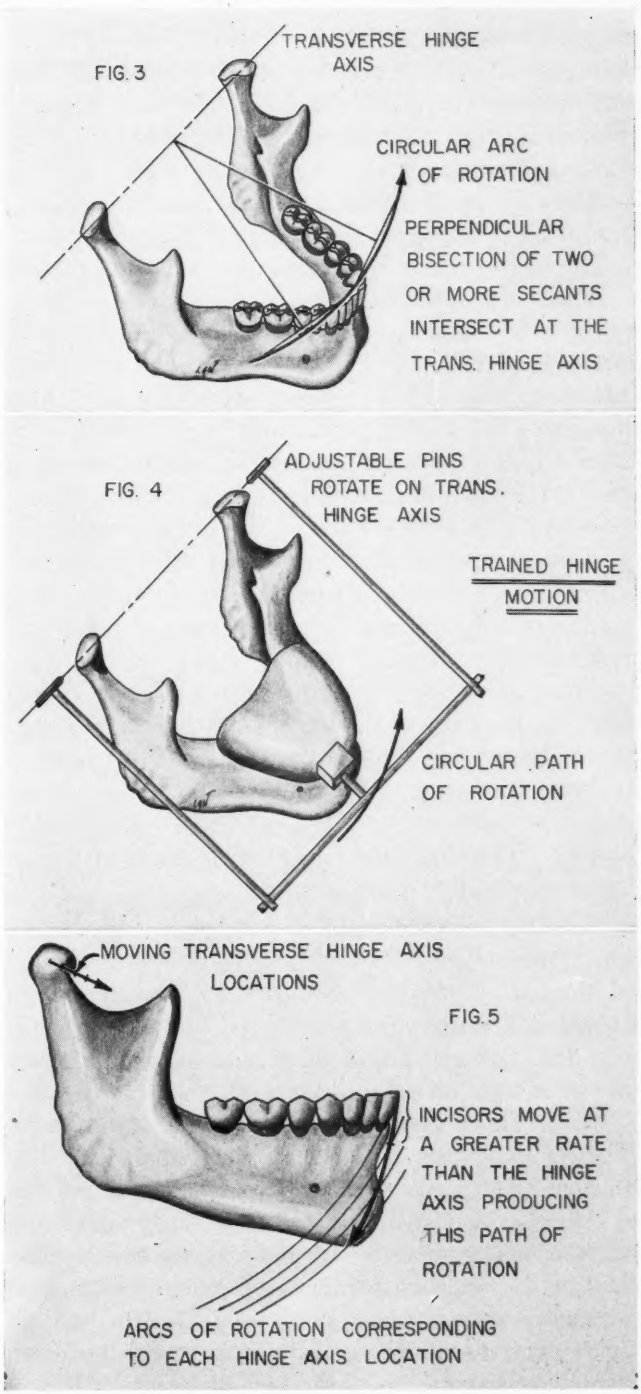


FIG. 3
TRANSVERSE HINGE AXIS
CIRCULAR ARC OF ROTATION
PERPENDICULAR BISECTION OF TWO OR MORE SECANTS INTERSECT AT THE TRANS. HINGE AXIS
FIG. 4
ADJUSTABLE PINS ROTATE ON TRANS. HINGE AXIS
TRAINED HINGE MOTION
CIRCULAR PATH OF ROTATION
MOVING TRANSVERSE HINGE AXIS LOCATIONS
FIG. 5
INCISORS MOVE AT A GREATER RATE THAN THE HINGE AXIS PRODUCING THIS PATH OF ROTATION
ARCS OF ROTATION CORRESPONDING TO EACH HINGE AXIS LOCATION

Figs. 3 to 5.—*For legends see facing page.*

LOCATION OF THE TRANSVERSE HINGE AXIS

Geometric Location of the Transverse Hinge Axis.—The transverse hinge axis can be located geometrically by erecting perpendiculars that bisect two or more secants of the circular path (Fig. 3). The transverse hinge axis is always perpendicular to the arm of rotation and vice versa. The transverse hinge axis usually passes through or near the condyles.

Clinical Location of the Transverse Hinge Axis.—A clutch and assembly which has two adjustable pins near the condyles is attached to the mandibular teeth (Fig. 4). The patient opens and closes in a trained (unstrained) rotational path of motion. When this path of motion is part of a circle (if the condyles do not translate), the pins of the assembly can be adjusted so that they only rotate. This locates the transverse hinge axis.

Moving Transverse Hinge Axis.—The function of a moving transverse hinge axis (untrained opening and closing) is seen in Fig. 5. Several hinge axis locations are illustrated on the condylar path. At the incisors the arc of rotation corresponding to each transverse hinge axis location is shown. When the points on each arc of rotation at the incisors are joined, the line represents the path of mandibular opening. The character of the mandibular rotational path, measured at the incisors, is dependent on the linear movement of the transverse hinge axis itself in relation to the incisor rotational movement. The ratio of these two factors alters the character of mandibular rotation.

Clinical Aspects of a Moving Transverse Hinge Axis.—Clinically, no purpose is served by recording the path of the moving transverse hinge axis (functional movement) without first locating the "starting" or terminal hinge position. During functional (translatory) movements, the pointer on the mandibular clutch assembly would merely scribe an arc (see Fig. 5) that would be useless for locating the terminal position. Therefore, the "trained" mandibular hinge movement is used to locate the nonmoving transverse hinge axis.

CLINICAL USE OF THE TRANSVERSE HINGE AXIS

The trained hinge movement has been criticized because the patient functions usually with condylar translation during opening. The trained hinge movement is used only to locate the starting point of mandibular opening and not the condylar path itself. The transverse hinge axis plus one other anterior point serves to locate the maxillae in space. Three separate points, or one hinge axis and an anterior point, are required to orientate any solid object in space. The interocclusal centric relation recordings are made usually in wax. The great misunderstanding is some believe that the mandible is forced posteriorly to record centric position. The real difference is one method records the transverse hinge axis physiologically (Gnathology), while face-bow mountings record it as an anatomic average usually within 5 mm. of error.

The location of the transverse hinge axis serves only to orientate the maxillae and to record the *static* starting point for functional mandibular movements. It does not record centric relation or condylar movements. Intraoral eccentric records are used with the Hanau type of adjustable articulator to estimate the

functional condylar movements concerned with cuspal occlusion. The Gnathoscope records condylar movements by means of extraoral records with extreme accuracy. *Moving* condyles are used in both methods without any trained hinge motion to obtain condylar path recordings. A simplified comparison of the basic concepts of the Hanau and Gnathoscope techniques is shown in Table I. It is *not* an evaluation of the two methods.

TABLE I

HANAU	GNATHOSCOPE
1 Estimated anatomic average location of the transverse hinge axis with a face-bow transfer	1 Physiologic location of the transverse hinge axis with a mandibular clutch assembly
2 Interocclusal centric relations recorded in wax, plaster, etc.	2 Interocclusal centric relations recorded in wax, plaster, etc.
3 Intraoral eccentric records estimate condylar paths for eccentric articulation	3 Extraoral eccentric records (etched in glass) accurately reproduce condylar movements for eccentric articulation

ONE OR TWO TRANSVERSE HINGE AXES

Transographics has been gaining in popularity, and some impressive literature has appeared in its favor.[3] It is important to note that excellent prosthetic work can be done on any adjustable articulator even though, in theory, its principles may be contradictory to others. The geometric distances involved and the relatively small range of cuspal contact (3 to 6 mm.) allows different clinical methods to arrive at equally good results.

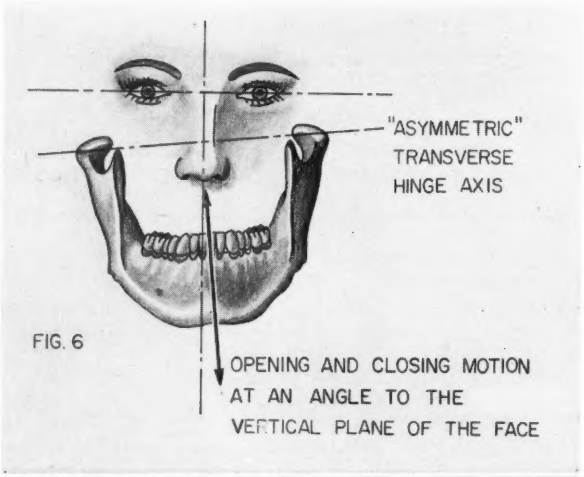
Condylar Asymmetry.—Much of the Transographic concept is based on the asymmetry of the condyles. This asymmetry depends on the orientation of some reference point or plane of motion to which the condyles are then related. The anatomic condylar asymmetry, as well as the observation that the mandible may open and close at a slight angle to the arbitrary vertical plane of the face, has led Page[3] to theorize that there are two independent transverse hinge axes, one for each condyle.

The slightly "off-center" opening and closing movements of the mandible are still perpendicular to the transverse hinge axis (Fig. 6). This movement is "off-center" only when we compare the opening and closing motion to our arbitrary orientation of the patient. The "off-center" motion is perpendicular to the transverse hinge axis and will deviate from the *arbitrary* vertical plane to the degree of deviation of the transverse hinge axis. We should orientate ourselves only to the transverse hinge axis and the two jaws.

Movement in one direction in a plane can have only one axis of rotation. Two axial centers of rotation for the same plane and direction of motion is a self-contradictory statement. If the mandible were rotating about one axis (Fig. 7, *A*), translation would have to occur in the other hinge axis (Fig. 7, *B*).

Physiologically, two independent hinge axes would require the translating condyle to change its vertical height. When this condyle serves as the hinge axis, the opposite condyle would then translate with a change in its vertical height. This

description is not consistent with the anatomy and physiology of the temporomandibular joint. The capsular ligament would not tolerate this degree of vertical movement. Second, the disk is nonvascular and thin in the central portion, allowing close contact with the temporomandibular fossa. An increase in vertical height of the condyle would be injurious.



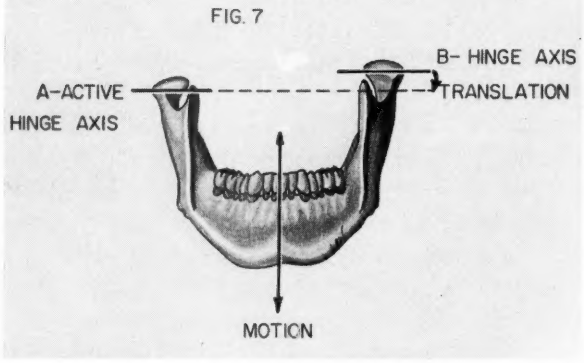
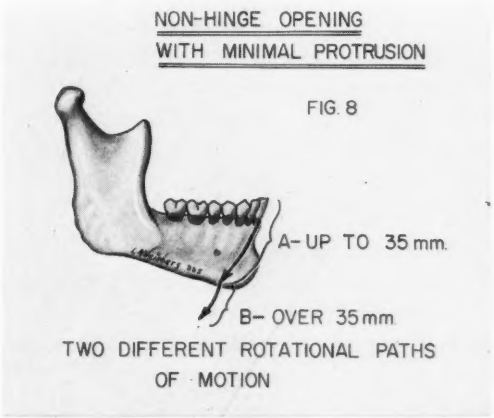


Fig. 6.—Condylar asymmetry. The opening and closing motion is at an angle to the vertical plane of the face, but it is still perpendicular to the transverse hinge axis.

Fig. 7.—The existence of two axial centers of rotation for the same plane and direction of motion is contradictory. When the mandible rotates about one axis *(A)*, the other so-called hinge axis *(B)* translates.

If the transverse axial center of motion shifts from one condyle to the other, as is claimed in Transographics, no coordinated opening and closing motion would be seen clinically. Instead, the pattern of mandibular motion would change as the axial center shifts from side to side. In normal opening and closing movements (up to 35 mm.), the motion follows a coordinated rotational pattern. I maintain that *marked* "off-center" opening is due to pathologic unilateral condylar limitation of motion producing a lateral component concerning three planes. The hinge axis determination is concerned with only one (sagittal) plane of motion.

Transograph.—Since it is impossible mechanically for a solid object to have two axial centers of rotation in the same plane for one direction of movement (open and close), the Transograph has a device that allows this flexing. The mandible itself cannot flex; therefore, we are to believe that the temporomandibular joints do flex.



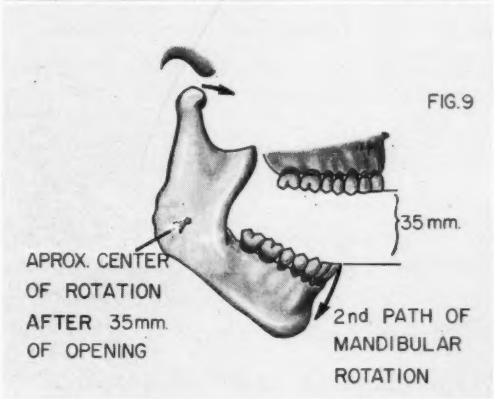


Fig. 8.—Two different rotational paths of motion are produced with a nonhinge opening with minimal protrusion. Curvature *(A)* is traced up to approximately 35 mm. of opening. With more than 35 mm. of opening, a different path of rotation develops *(B)*.

Fig. 9.—The transverse hinge axis of rotation shifts inferiorly along the ramus of the mandible as the condyles go past the articular eminence (more than 35 mm. opening). The movement pattern changes as indicated by the second path of rotation.

MANDIBULAR MOTION PATTERN

The pattern of movement of the lower incisors during opening and closing with minimum protrusion is shown in Fig. 8. Two distinct curvatures are seen from the lateral aspect. The first rotational path is traced usually up to approximately 35 mm. of opening measured at the incisors. A different path of rotation develops with more than 35 mm. of opening. This pattern of motion indicates that the first 35 mm. of opening results from a moving transverse hinge axis located through or near the condyles. As the condyles go past the articular eminence (more

than 35 mm. of opening), the movement pattern changes (Fig. 8, *B*). This new pattern of motion indicates that the transverse hinge axis of rotation shifts inferiorly along the ramus of the mandible (Fig. 9). The transverse hinge axis shift, after 35 mm. of opening, should not be confused with the Transographic concept of two independent transverse axes for all ranges of motion.

The significance of this change in location of the transverse hinge axis should be stressed. The motion of a physiologic body is controlled by a complex of ligaments, muscles, and joints. The teeth in contact also exert an influence on mandibular movement. The anatomic curvatures of the surface of the condyles do not control mandibular movement as a similarly shaped steel machine would function. Page[3] stresses this lack of a perfect spherically shaped condyle as an indication that a true hinge axis motion is impossible. This would be true with an oval-shaped steel ball in intimate contact with an unyielding housing. There is a disk as well as two synovial joint cavities and tissues between the condyle and the temporomandibular fossa involved. Only a small part of the total articulating surface of the condyle is concerned with the normal range of motion. Therefore, the elliptical bony surface of the condyle does not preclude the hinge type of *trained* opening and closing.

A complex system of muscles and ligaments is functioning with the condyles to produce motion. The shifting of the axial center of rotation away from the condyles (with more than 35 mm. opening) indicates that the condylar anatomy itself is not the only factor in mandibular movements.

CLINICAL EVIDENCE OF THE TRANSVERSE HINGE AXIS

Physiologic mandibular opening, trained or untrained, assumes a rotational pattern. Whether this rotational pattern is part of an ellipse or a circle merely depends upon whether or not the hinge axis is moving. Any coordinated rotational motion must have an axis of rotation. There can be no argument against this engineering fact, but whether we can record it, transfer it, or utilize it is another topic for discussion.

PIN-POINT LOCATION OF THE TRANSVERSE HINGE AXIS

Borgh and Posselt[4] experimented with the transfer of hinge axis recordings from one articulator to another to evaluate the tattooing of its location on the patient. The transverse hinge axis was duplicated exactly several times, and other times it varied several millimeters. It is pertinent to evaluate the effect of a transverse hinge axis error of 5 mm. on the occlusion of the teeth. We can then evaluate the physiologic method of transverse hinge axis location (Gnathology) compared to the anatomic average method (Hanau face-bow).

Theoretically, unless we locate and transfer the exact transverse hinge axis, any interocclusal space used in the making of jaw relation records will induce error as the articulator swings closed to the proper vertical height. The magnitude of the error produced at the occlusal surfaces will indicate the value of a particular procedure. A simple geometric problem was set up using average distances to evaluate this degree of error.

The wax interocclusal centric relation record was 3 mm. thick between the second molars; the geometric distances are shown in Fig. 10. The face-bow transfer was located 5 mm. too far posteriorly (Fig. 11). When the wax record was removed and the articulator closed, an error of 0.1934 mm. at the second molar was produced (for mathematics, see Figs. 14 to 16).

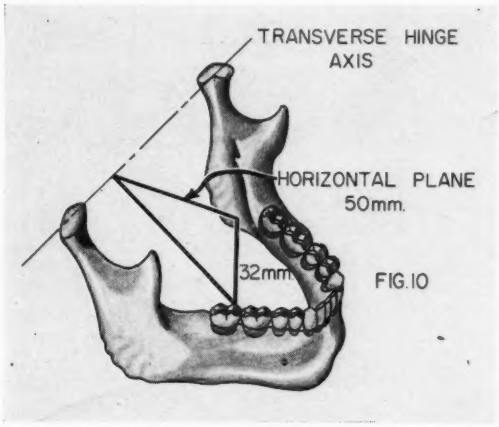


Fig. 10.—A simple geometric problem is presented to demonstrate the effect of an error of 5 mm. in the location of the transverse hinge axis on the occlusion of the teeth. The wax interocclusal centric relation record is 3 mm. thick at the second molar area. The second molar is 50 mm. from the transverse hinge axis measured as a perpendicular along the horizontal plane. The molar is 32 mm. inferior to this horizontal plane.

The magnitude of the error was even less when the same procedure was repeated with the anterior teeth (Fig. 12). The face-bow transfer had the same 5 mm. error. When the wax (6.06 mm. thick at the incisors) was removed and the articulator closed, the error produced at the incisors was 0.1044 mm. (Fig. 13).

CLINICAL EVALUATION OF THE ERROR PRODUCED

The anatomic transverse hinge axis location and the subsequent face-bow transfer within a 5 mm. error is a practical and dependable method for orientating the maxillary cast. Interocclusal centric relation records that limit the interocclusal opening to 6 mm. at the incisors produce a negligible error (0.1044 mm. at the incisors with the average dimensions used). The anatomic face-bow hinge axis location should be within 5 mm. of the actual transverse hinge axis of the patient. The gross error that is produced clinically is not due to the hinge axis location or mounting but to the centric relation record itself.

RELATION OF THEORETIC FACTORS TO CLINICAL PRACTICE

Eccentric Contact.—Most patients have eccentric occlusal contact with some types of food, and almost all patients exhibit signs of occasional bruxism.[6] It is our responsibility then to produce harmonious eccentric contacts that prevent trauma to a few teeth. This requires the use of some type of adjustable articulator.

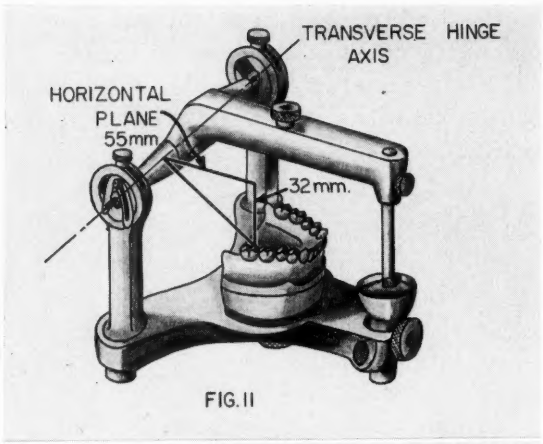


FIG. 11

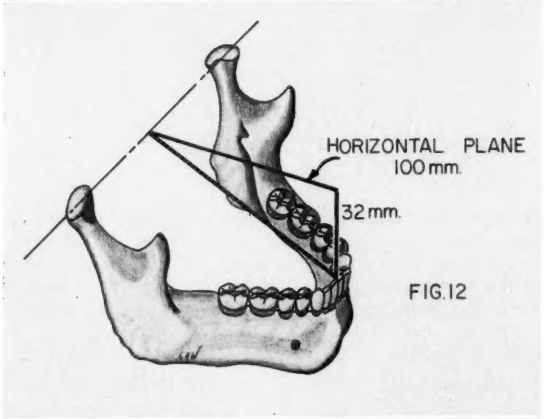


FIG. 12

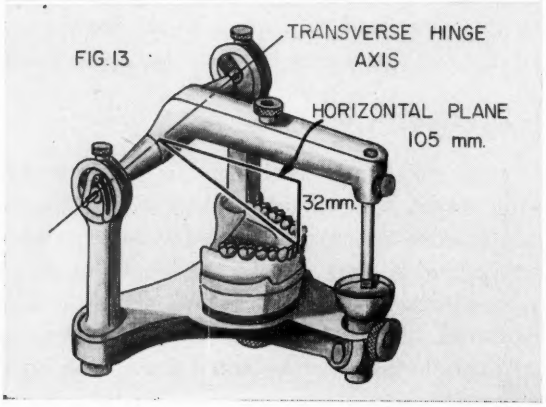


Fig. 11.—The face-bow transfer is located 5 mm. too far posteriorly, making the perpendicular-horizontal distance to the transverse hinge axis 55 mm. on the articulator. The molar is still 32 mm. below the horizontal plane. When the wax record is removed and the articulator closed, an error of 0.1934 mm. at the second molar is produced (for mathematics, see Figs. 14 to 16.)

Fig. 12.—The same procedure is repeated with the anterior teeth, and the magnitude of the error is even less than for the posterior teeth. The arbitrary horizontal distance of the incisors from the transverse hinge axis of the patient is 100 mm. The incisal edge of the central incisor is 32 mm. below this horizontal plane.

Fig. 13.—The face-bow transfer is located 5 mm. too far posteriorly, making the horizontal distance on the articulator 105 mm. When the wax centric relation record (6.06 mm. at the incisors) is removed and the articulator closed, the error produced at the incisor is 0.1044 mm.

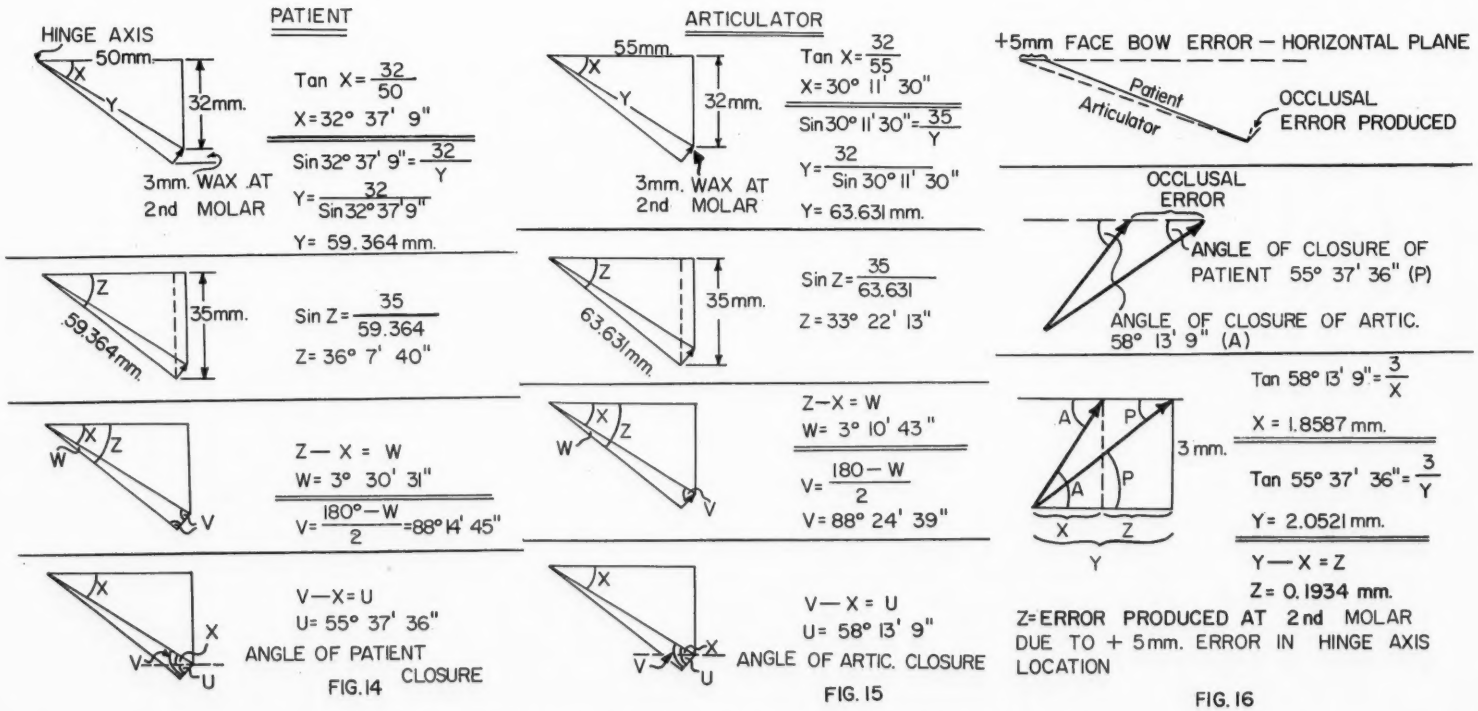

PATIENT
HINGE AXIS
50mm.
32mm.
3mm. WAX AT 2nd MOLAR
Tan X = 32/50
X = 32° 37' 9"
Sin 32° 37' 9" = 32/Y
Y = 32 / Sin 32° 37' 9"
Y = 59.364 mm.
35mm.
Sin Z = 35/59.364
Z = 36° 7' 40"
Z — X = W
W = 3° 30' 31"
V = (180° — W)/2 = 88° 14' 45"
V — X = U
U = 55° 37' 36"
ANGLE OF PATIENT CLOSURE
FIG. 14
ARTICULATOR
55mm.
32mm.
3mm. WAX AT 2nd MOLAR
Tan X = 32/55
X = 30° 11' 30"
Sin 30° 11' 30" = 35/Y
Y = 32 / Sin 30° 11' 30"
Y = 63.631 mm.
35mm.
Sin Z = 35/63.631
Z = 33° 22' 13"
Z — X = W
W = 3° 10' 43"
V = (180 — W)/2
V = 88° 24' 39"
V — X = U
U = 58° 13' 9"
ANGLE OF ARTIC. CLOSURE
FIG. 15
+5mm FACE BOW ERROR — HORIZONTAL PLANE
Patient
Articulator
OCCLUSAL ERROR PRODUCED
OCCLUSAL ERROR
ANGLE OF CLOSURE OF PATIENT 55° 37' 36" (P)
ANGLE OF CLOSURE OF ARTIC. 58° 13' 9" (A)
3 mm.
Tan 58° 13' 9" = 3/X
X = 1.8587 mm.
Tan 55° 37' 36" = 3/Y
Y = 2.0521 mm.
Y — X = Z
Z = 0.1934 mm.
Z = ERROR PRODUCED AT 2nd MOLAR DUE TO + 5mm. ERROR IN HINGE AXIS LOCATION
FIG. 16

Fig. 14.—Computation of the angle of closure of the patient's mandible.
Fig. 15.—Computation of the angle of closure on the articulator.
Fig. 16.—Computation of the error produced by the error in mounting.

Any fixed restoration or tooth-borne removable partial denture should finally be equilibrated in the mouth by following a definite method of equilibration.[7-12]

Purpose of the Transverse Hinge Axis Determination.—In order to use an adjustable articulator, the transverse hinge axis must be located and transferred to the instrument. Two different hinge axes, one for each condyle, are theoretically and practically impossible. Therefore, Transographics, on a theoretic basis, is rejected, although, due to the geometry, the error produced can be small enough so that such a dogmatic clinical point of view may be avoided.

Face-bow: Anatomic Transverse Hinge Axis Location and Transfer.—Location of the transverse hinge axis with the anatomic average location and mounting with a face-bow is a scientifically acceptable technique. Centric relation records made within 6 mm. of opening at the incisors produce negligible error (0.1044 mm. with the average distances illustrated) with a 5 mm. posterior error in the location of the transverse hinge axis.

Pin-Point Location of the Transverse Hinge Axis.—The 2 to 3 mm. variation sometimes found in the physiologic transverse hinge axis location does not exclude Gnathology or the soundness of tattooing. An error of 2 to 3 mm. in the location of the transverse hinge axis produces such a slight occlusal discrepancy that no centric relation record or cementation could be equally accurate.

Articulators.—An adjustable articulator is essential for reconstruction of complete or partial denture prosthesis. The Transographic theory of two independent transverse hinge axes, one for each condyle, has been rejected. The Gnathoscope and the Hanau type of adjustable articulators seem to be based on more theoretically acceptable principles.

SUMMARY

A theoretic and clinical discussion of the transverse hinge axis has been presented in relation to some of the controversial concepts of occlusion and articulators. In the final analysis, the true value of our individual work can be measured only by the degree of fineness with which we practice the art of dentistry rather than by the particular school of thought to which we adhere.

REFERENCES

1. McCollum, B. B.: Fundamentals Involved in Prescribing Restorative Dental Remedies, D. Items Interest **61**:522-535, 641-648, 724-736, 852-863, 942-950, 1939.
2. Cohen, R.: The Relationship of Anterior Guidance to Condylar Guidance in Mandibular Movement, J. Pros. Den. **6**:758-767, 1956.
3. Page, H. L.: Some Confusing Concepts in Articulation, D. Digest **64**:71-76, 120-124, 1958.
4. Borgh, O., and Posselt, U.: Hinge Axis Registration: Experiments on the Articulator, J. Pros. Den. **8**:35-40, 1958.
5. Jankelson, B.: Physiology of Human Dental Occlusion, J.A.D.A. **50**:664-685, 1955.
6. Weinberg, L. A.: Force Distribution in Mastication, Clenching, and Bruxism, D. Digest **63**:58-61, 116-120, 1957.
7. Blass, J. L.: Occlusal Equilibration in Periodontal Treatment, New York State D. J. **22**:121-129, 1956.
8. Miller, S. C.: Textbook of Periodontia, ed. 3, Philadelphia, 1950, The Blakiston Co., pp. 343-384.
9. Schuyler, C. H.: The Correction of Occlusal Disharmony of the Natural Dentition, New York State D. J. **13**:545-562, 1947.

10. Sorrin, S.: Traumatic Occlusion, Its Detection and Correction, D. Digest **40**:170-173, 202-208, 1934.
11. Simring, M.: Occlusal Equilibration of the Dentition, J.A.D.A. **56**:643-655, 1958.
12. Weinberg, L. A.: A Visualized Technique of Occlusal Equilibration, J. D. Med. **7**:9-15, 18-26, 1952.
13. Weinberg, L. A.: A Visualized Technique for Equilibration of Atypical Occlusal Relationships, Oral Surg., Oral Med. & Oral Path. **9**:516-528, 1956.

515 Ocean Ave.
Brooklyn 26, N.Y.

AMERICAN DENTAL ASSOCIATION
100 YEARS
1859 · 1959

MORE ON THE BENNETT MOVEMENT

RAYMOND COHEN, D.D.S.
New York, N. Y.

IN 1908, BENNETT[1] reported the results of an experiment he performed in order to study and evaluate the movements of the mandible. Of his entire experiment, the part the dental profession remembers is that portion where Bennett describes a lateral shift of the condyle in any lateral excursion of the mandible. This is known today as the Bennett movement.

Landa[2] has spent much time and effort in trying to disprove this contention of Bennett's. The movement that Bennett describes is merely a statement of a fact. It is not possible for the mandible to move laterally without either one or both condyles to move with a lateral component of motion. The entire mandible is a solid body from condyle to condyle. It is inconceivable that the mandible can move laterally without some lateral movement of either one or both condyles. The fact that Landa has not been able to see this indicates either that his experiments were inadequate or that his observations were incorrect.

Landa interpreted only half of what Bennett said about the movement of the condyle. Bennett showed that it was not only the condyle on the working side that moved laterally during lateral excursion of the mandible but that there is a lateral movement of the condyle on the balancing side. This latter point was completely ignored in Landa's study.

Landa, in his conclusions, takes issue with the use of the word "considerable" by Bennett. In his article Bennett mentions the fact that in extreme lateral movement of the condyle it (the condyle) moved 3 mm. This is "considerable" to Bennett. To others, 3 mm. may not be "considerable."

Draw a triangle with two equal sides and one shorter side to represent the mandible (Fig. 1). Let the terminals of the shorter side represent the centers of rotation of each of the condyles *A* and *B*. Let the other point of the triangle represent a point in the mandible in the incisor area, *C*. *XY* is a straight line passing through *C* which is perpendicular to the hinge axis *AB*. The point *C* if moved to *X* would represent a straight protrusive movement of the mandible. *AE* and *BF* are straight lines drawn parallel to *XY* and pass through points *A* and *B*, respectively. These lines, *AE* and *BF*, represent a straight protrusive movement of condyles *A* and *B*. Move incisor point *C* in any direction laterally away from the line *XY;* for example, to point *D*. (Point *C* on the mandible, in lateral movement, always moves more or less forward.) In order for the incisor point *C* to move to *D*, one of several things occurs at points *A* and *B:*

Received for publication Oct. 24, 1958.

1. If there is pure rotation at *B*, *A* will move forward and to the right; thus, condyle *B* will exhibit no Bennett movement but condyle *A* will.

2. If condyle *B* moves directly to the right, condyle *A* will move forward and to the right. Thus, both condyles will execute the Bennett movement.

3. If condyle *B* moves directly forward, condyle *A* will move forward and to the right. Condyle *B* does not have a Bennett movement but *A* does. While this type of movement is a possibility, it is not very likely to occur. In the many condylar registrations I have recorded I have seen this type of movement very seldom.

4. If *B* moves backward and to the right, *A* will move forward and to the right. Thus, both condyles execute a Bennett movement.

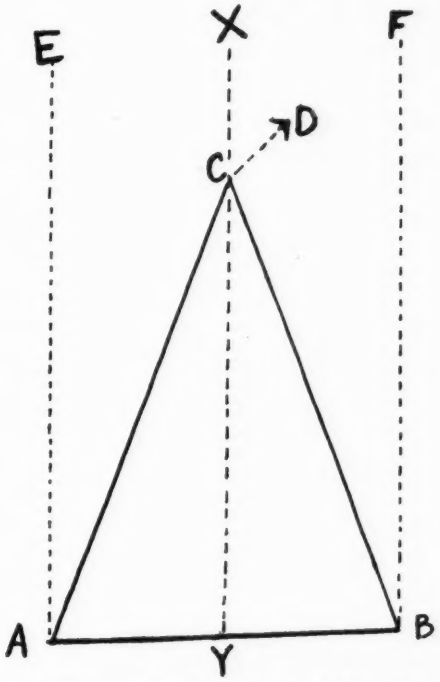


Fig. 1.—A diagrammatic representation of mandibular motion in a horizontal plane.

Using the diagram (Fig. 1), it is not possible to move the triangle *ABC* by moving point *C* to point *D* without either or both points *A* and *B* leaving lines *AE* and *BF*. Therefore, there must be a lateral movement of one or both condyles in any lateral movement of the mandible.

Since the mandible is a solid body of bone from condyle to condyle, it is physically impossible for the mandible to move laterally without causing one or both condyles to move with a lateral component of motion (Bennett movement).

The significance of the Bennett movement to dentistry and to humanity lies in the fact that it is the movement of the mandible occurring during mastication. It is a factor that influences the relationship of the mandible to the maxillae at the time when the greatest amount of muscular force is applied to the teeth.* It is

*Granger, E. R.: Personal communication.

for this reason that it is so very important to reproduce the Bennett movement. It has been shown that the path of movement of the condyle is immutable,[3] and thanks to McCollum[4] and the Gnathological Society it is possible to record and reproduce exactly the various paths of movement of the condyle—including the Bennett movement.

REFERENCES

1. Bennett, N. G.: A Contribution to the Study of the Movements of the Mandible, J. Pros. Den. **8**:41-54, 1958.
2. Landa, J. S.: A Critical Analysis of the Bennett Movement, J. Pros. Den. **8**:709-726, 865-879, 1958.
3. Cohen, R.: The Relationship of Anterior Guidance to Condylar Guidance in Mandibular Movement, J. Pros. Den. **6**:758-767, 1956.
4. McCollum, B. B.: A Research Report. Fundamentals Involved in Prescribing Restorative Dental Remedies, D. Items Interest **61**:522-530, 641-648, 724-736, 852-863, 942-950, 1939.

1350 Broadway
New York 18, N. Y.

THE EFFECT OF BONWILL'S TRIANGLE ON COMPLETE DENTURES

FINN TENGS CHRISTENSEN, L.D.S.*
Stavanger, Norway

VARIATIONS IN THE SIZE of Bonwill's triangle (Fig. 1) influence the cusp angulation for complete dentures. According to Bonwill,[1] the length of each side, with few exceptions, is equal to 10 cm. (exactly 4 inches). Bonwill based his theory on measurements of 6,000 skulls and 4,000 living persons. However, the correctness of his theory has been questioned.

Bosse[2] measured 500 jaws and found a marked variation in the distance between the condyles. He found an average distance of 96 mm. by measuring from the middle of the mesial surface of one condyle to the lateral surface of the other. Choquet[3] measured 149 mandibles and found that the external distance between the condyles was between 138 and 97 mm. and the internal distance was between 96 and 65 mm. He mentions the asymmetric position of the condyles[4] as does Welcher[5] who found only 2 symmetric condyles in 50 mandibles. Frahm[6] also maintains the asymmetry of the condyles, and Amoedo[7] found the distance between the condyles varied from 7 to 13 cm. Wilson[8] examined 300 jaws and found 6 per cent in accordance with Bonwill's theory. However, these men measured jaws on dried skulls, and dried bones change form. Welcher[5] demonstrated the change in form by dipping dried mandibles in water. The intercondylar distance of one mandible *increased* more than 10 mm. during a period of one hour in water. After drying again for some weeks, the distance *decreased* about 13 mm. The intercondylar size of the mandible was also about 3 mm. less than before the beginning of the experiment. In addition, the height of the human body of Scandinavian peoples has increased in the last hundred years and has for most civilized people all over the world. However, the size of the dental arch, at the same time, has had a tendency to decrease.[9]

The result of Bonwill's measurements on living persons is not sufficient as scientific proof, and the question concerning the average size of Bonwill's triangle is still confused. However, the construction of average articulators is generally in accordance with Bonwill's theory, and Monson's pyramid[10] is based also on Bonwill's triangle. In this article the average size of Bonwill's triangle is used, and it is assumed to be an equilateral triangle, the angles of which are formed, respectively, by the incisal point and the two condyles. The sides (s in Fig. 1) are assumed to be 100 mm. in length. The height of the triangle (a in Fig. 1) is consequently equal to 100 mm. $\times$ sine 60 degrees. The dorsal line in Bonwill's tri-

Received for publication Aug. 26, 1958.
*Assistant Professor, Norwegian State Dental School, Oslo, Norway.

angle is assumed to be identical with the condylar axis. In clinical work it is advantageous to make the dorsal line of Bonwill's triangle identical with the condylar axis. The average gauge of Bonwill's triangle is otherwise of less importance since the intention is to clarify how variations in the length of the sides (height) of Bonwill's triangle exert influence on the cusp angulation. Stated specifically: What is the effect on cusp angulation when the distance from the incisal point to the condylar axis is altered?

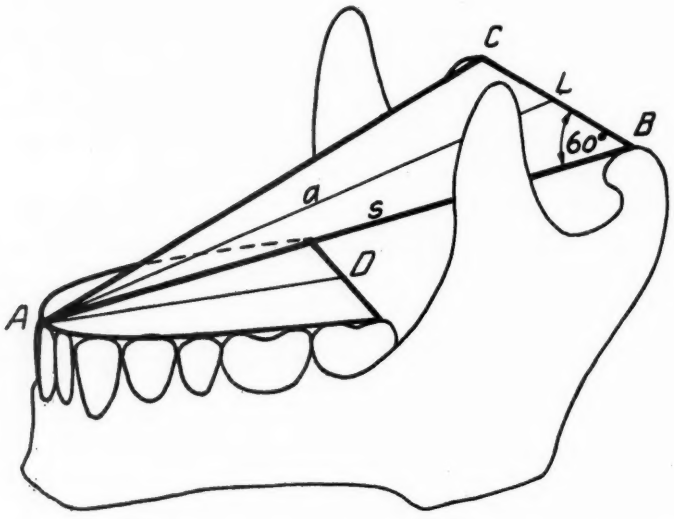


Fig. 1.—The Bonwill triangle *ABC*. The ratio between the height *(a)* and the sides *(s)* in Bonwill's triangle is $a = s \times \text{sine } 60 \text{ degrees}$. The angle *LAD* is the Balkwill angle ($= \phi$ in the formula for the Christensen angle).

CHRISTENSEN'S ANGLE

In this investigation the condylar guide inclination, the incisal guide inclination, and the cusp angulation are angles in a sagittal plane or projections in the median plane. The calculation of the cusp angulation for complete dentures is based on the *Christensen phenomenon* and depends on the size of the *Christensen angle.*[11] Therefore, it is suitable to examine how the size of Bonwill's triangle influences the Christensen angle. The supposition for the calculation of the Christensen angle is a straight condylar path with a common inclination on each side. By the inclination of the condylar guidance is meant the inclination of the sagittal condylar guidance to the plane of occlusion, and by *protrusion* is meant forward protrusion of the mandible. The incisal point in protrusion is assumed to be displaced into or parallel with a maxillary occlusion rim with flat occluding surfaces when there is no inclination of the incisal guidance and no compensating curve of occlusion.

When the incisal guide inclination is equal to the condylar guide inclination, the cusp angulation has to be of the same size, independent of the size of Bonwill's triangle (Fig. 2). By varying the compensating curve, the cusp angulation may be

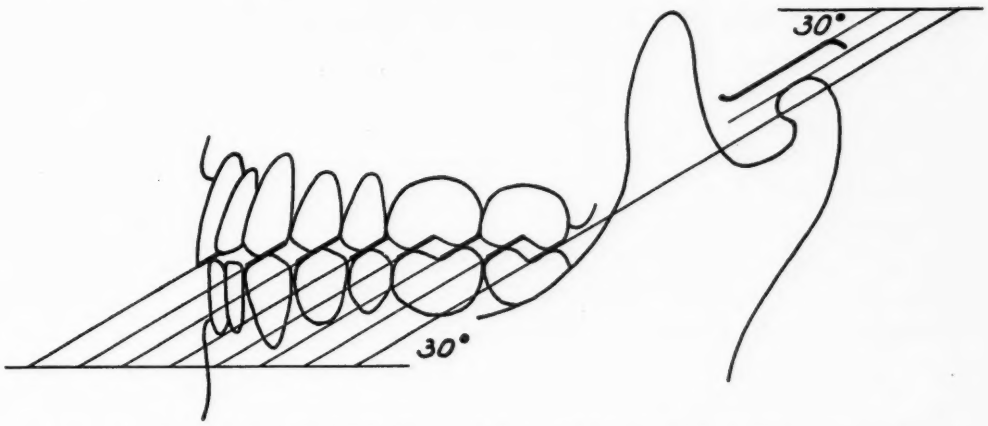


Fig. 2.—The incisal guide inclination and the condylar guide inclination are equal. The incisal point and the projection of the condylar axis move on parallel paths. To maintain antagonistic tooth contact along the entire length of the protrusive facets, the sagittal cusp angulation of all of the cusps must be of the same size as the inclination of the condylar and the incisal guidance, independent of the size of Bonwill's triangle.

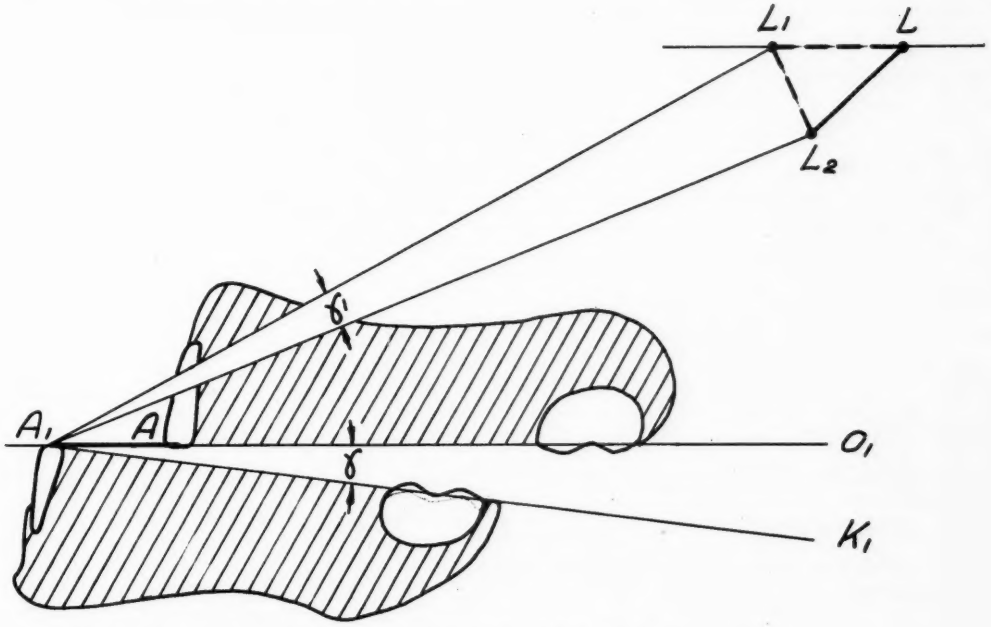


Fig. 3.—The relation between Bonwill's triangle and the Christensen angle.

A, The incisal point in the centric occlusion.

A_1, The incisal point after protrusive movement with an incisal guide inclination of 0 degree.

AA_1, The length of the protrusion ($= LL_1$).

L, The condylar axis in centric relation.

L_1, The condylar axis after protrusive movement with a condylar guide inclination of 0 degree.

LL_1, The size of protrusion ($= AA_1$).

L_2, The condylar axis after protrusive movement on a condylar path equal to LL_2.

The angles γ and γ_1 are formed as a result of the movement of point L_1 to the line LL_2 (the condylar path) on the periphery of a circle with A_1 as the center and A_1L_1 as a radius. The Christensen angle $O_1A_1K_1$ (γ) is equal to the angle $L_1A_1L_2$ (γ_1). The line $L_1A_1 = L_2A_1$ is the distance from the incisal point to the condylar axis and equals the height in Bonwill's triangle. By an increase of the height of Bonwill's triangle (A_1L_1 and A_1L_2), the size of the Christensen angle decreases (see Fig. 4).

altered in accordance with Hanau's Quint[12] or Thielemann's Formula of Articulation.[13] The theory of the Christensen angle is shown in Fig. 3, and the relationship between the height of Bonwill's triangle ($a_1a_2a_3$) and the corresponding Christensen angle ($\gamma_1\gamma_2\gamma_3$) is shown in Fig. 4. It can be seen that the Christensen angle (γ) decreases if the height in Bonwill's triangle *(a)* increases. The size of the Christensen angle increases from 0.3 to 3.53 degrees by an alteration of the condylar guide inclination from 5 to 60 degrees during 5 mm. of protrusion.[11] It turns upon small angles ($\gamma_1\gamma_2\gamma_3$). The ratio between small angles is equal to the ratio of the sine to the angles. Therefore, where a_1 and a_2 are the respective heights of Bonwill's triangles, we get the following ratio:

$$\frac{\gamma_1}{\gamma_2} = \frac{\text{sine } \gamma_1}{\text{sine } \gamma_2} = \frac{\frac{\frac{1}{2}L_1L_2}{a_1}}{\frac{\frac{1}{2}L_1L_2}{a_2}} = \frac{a_2}{a_1},$$

that is,

$$\frac{\gamma_1}{\gamma_2} = \frac{a_2}{a_1} \quad \text{(see Fig. 4).}$$

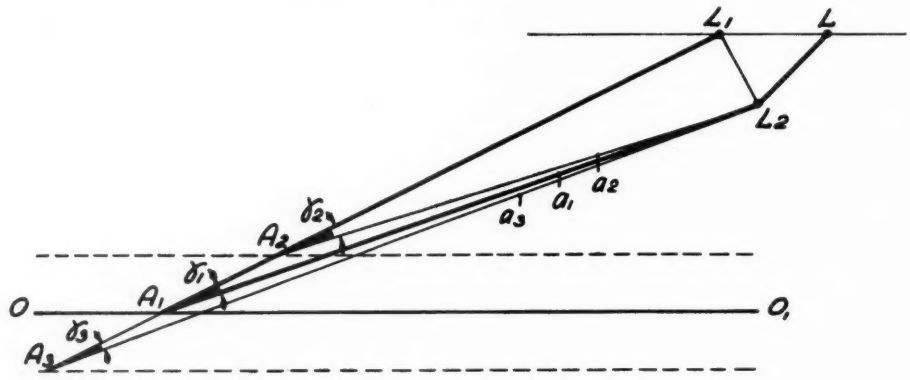


Fig. 4.—The ratio between the Christensen angle ($\gamma_1\gamma_2\gamma_3$) by varying the height ($a_1a_2a_3$) in Bonwill's triangle (based on Fig. 3).

γ_1, The Christensen angle with the height in Bonwill's triangle equal to $a_1 = L_1A_1 = L_2A_1$.

γ_2, The Christensen angle with the height in Bonwill's triangle equal to $a_2 = L_1A_2 = L_2A_2$.

γ_3, The Christensen angle with the height in Bonwill's triangle equal to $a_3 = L_1A_3 = L_2A_3$.

The Christensen angle decreases with an increase of the height in Bonwill's triangle.

The height in Bonwill's triangle is proportional to the size of the sides (see Fig. 1 where $a = s \times$ sine 60 degrees). In consequence the Christensen angle (γ) is inversely proportional to the height (sides) of Bonwill's triangle. The formula for the Christensen angle is: sine $[(\beta \div \phi) + \gamma]$ = sine $(\beta \div \phi) + \frac{p}{a}$ sine β.[11] In this formula a is the height in Bonwill's triangle (see Fig. 1), ϕ is the Balkwill angle (*LAD*, Fig. 1), β is the condylar guide inclination, γ is the Christensen angle, and p is the length of protrusion of the mandible.

The effect on the Christensen angle of varying the length of the sides of Bonwill's triangle is seen in Table I. Table I and its graphic reproduction (Fig. 5)

TABLE I. THE CHRISTENSEN ANGLE BY VARYING THE SIZE OF THE SIDES (HEIGHT) IN BONWILL'S TRIANGLE

s / β	110 *mm.* (a = 110 *mm.* × *sine* 60°)	100 *mm.* (a = 100 *mm.* × *sine* 60°)	90 *mm.* (a = 90 *mm.* × *sine* 60°)
15°	0.79° (0.79°)	0.87° (0.87°)	0.97° (0.97°)
30°	1.51° (1.51°)	1.66° (1.66°)	1.85° (1.84°)
45°	2.26° (2.27°)	2.50° (2.50°)	2.78° (2.78°)
60°	3.20° (3.21°)	3.53° (3.53°)	3.94° (3.92°)

a = the height in Bonwill's triangle. β = the condylar guide inclination. s = one side in Bonwill's triangle.

Balkwill's angle is 26 degrees and the protrusion of the mandible is 5 mm.

The ordinary figures indicate the Christensen angle according to the formula for the Christensen angle. Figures in parentheses indicate the corresponding size of the Christensen angle, calculated in accordance with the formula: $\frac{\gamma_1}{\gamma_2} = \frac{a_2}{a_1}$. The difference between the figures is insignificant.

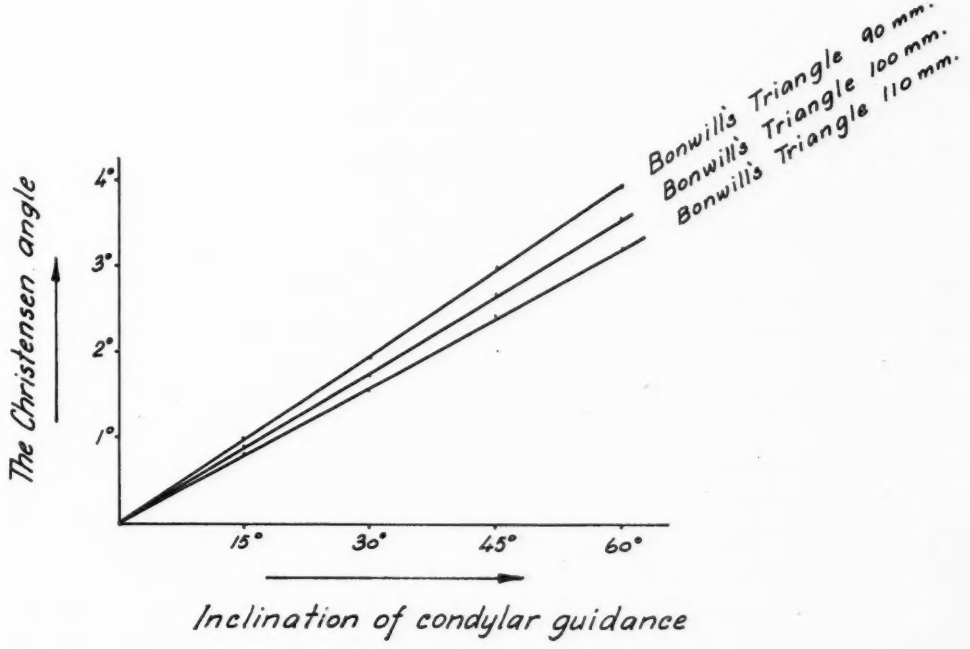


Fig. 5.—Graphic reproduction of Table I.

confirm the conclusions based on Fig. 4. The Christensen angle decreases with an increase of Bonwill's triangle. At a condylar guide inclination of 30 degrees, the

Christensen angle is 1.85 degrees when the length of the side of Bonwill's triangle is 90 mm. When the length of the side is 110 mm., the Christensen angle is 1.51 degrees. On complete dentures the cusp angulation (E) is proportional to the Christensen angle.[11] Consequently, in the formula $\frac{\gamma_1}{\gamma_2} = \frac{a_2}{a_1}$ the Christensen angle (γ) can be replaced with the cusp angulation (E), resulting in

$$\frac{E_1}{E_2} = \frac{a_2}{a_1}.$$

CONCLUSION

With the conditions as specified, the degree of the cusp angulation for complete dentures is inversely proportional to the height (sides) of Bonwill's triangle.

REFERENCES

1. Bonwill, W. G.: The Scientific Articulation of the Human Teeth as Founded on Geometrical, Mathematical, and Mechanical Laws, D. Items Interest **21**:617-643, 873-880, 1899.
2. Bosse, U.: Beiträge zur Anatomie des Mänschlichen Unterkiefers (Diss.), Verlag: Otto Kümmel. Kønigsberg in Pr. 1901.
3. Choquet, J.: Le Triangle equilateral de Bonwill, L'odontologie **41**:307-312, 1909.
4. Choquet, J.: Asymétrie condylienne du maxillaire inferieur, L'odontologie **51**:5-8, 1914.
5. Welcher, H.: Die Zugehörigkeit eines Unterkiefers zu einem Bestimmten Schädel, Arch. f. Anthrop. **27**:37-106, 1902.
6. Frahm, F. W.: Studies of the Human Masticatory Apparatus and Its Relations to the Prosthodontist, and Treatment of the Same, D. Cosmos **56**:533-550, 1914.
7. Amoedo, O.: Simplification dans l'enregistrement de la trajectoire condylienne, Revue trimestrielle suisse d'odontologie **23**:157-175, 1913.
8. Wilson, G. H.: The Anatomy and Physics of the Temporomandibular Joint, Bull. Nat. D. A. **8**:236-241, 1921.
9. Lundström, A.: Vilka Förändringar ha Inträffat Infråga om Käkarnas Storlek och Occlusionsförhållanden under Historisk Tid? Svensk. T. T. **39**:391-424, 1946 (with English summary, p. 420).
10. Monson, G. S.: Occlusion as Applied to Crown and Bridge Work, Bull. Nat. D. A. **7**:399-413, 1920.
11. Christensen, F. T.: Cusp Angulation for Complete Dentures, J. Pros. Den. **8**:910-923, 1958.
12. Hanau, R. L.: Full Denture Prosthesis: Intraoral Technique for Hanau Articulator Model H, ed. 4, Buffalo, 1930, the author, p. 37.
13. Thielemann, K.: Biomechanik der Paradentose, Berlin, 1938, Hermann Meusser Verlag, p. 24.

Kannikgaten 13
Stavanger, Norway

CURVED OCCLUSAL PLANES ARE CONTRAINDICATED

HONORATO VILLA A., D.D.S.
Mexico, D. F.

EXPERIMENTAL GEOMETRY AND KINEMATIC EXPERIMENTS have shown that the elliptical principle solves in a logical way the engineering problems in denture construction.[1] These demonstrations in movement, rather than the use of misleading drawings, are the only way in which the truth is discovered. In this article a report will be made on a study of "chew-ins" and curved occlusal planes developed by templates or other means.

Schweitzer[2] states, "In the 'chew-in' technique, as described by Christensen in 1902, and by Patterson and Meyer, interocclusal waxes were used with plaster or Carborundum paste in a special trough built in the occlusion rims, and functional paths were generated. I have often wondered why there was always a space between the posterior ends of the generated paths. I remember the advice to take the upper second molars out of occlusion in edentulous cases." I shall try to explain the reason for this space.

In these techniques a primary curve is produced on the occlusal surface of the occlusion rims. Sometimes flat posterior teeth are set directly on this primary curve, and sometimes the rims are placed in the mouth to produce individual curves by the "chew-in" method. This condition is represented schematically in Fig. 1.

The occlusion rims are made of plaster to which was added an abrasive material. An equilateral triangle was drawn using the distance from the condyle to the anterior part of the rims for the length of each side. The occlusal curve was traced from the upper angle of the triangle. The condylar path was set at an inclination of 30 degrees.

A protrusive movement was made, and it was observed that a premature contact exists in the posterior part of the rims because of the occlusal curvature (Fig. 2). The abrading action of repeated movements will cause a space to be developed in the posterior part of the rims which, in turn, will cause a premature contact of the anterior teeth when the patient closes in centric relation.

The width of the space produced depends upon the inclination of the condylar path. The inclination of the path was reduced, and during a protrusive movement the posterior premature contact was more pronounced, producing a wider space in the anterior part of the rims (Fig. 3). When the "chew-in" is made, a wider separation will thus be produced in the posterior portion of the rims.

Next, the inclination of the condylar path was increased. When a protrusive movement was executed, the space in the anterior part of the rims was narrower

Received for publication June 16, 1958.
This is the sixth of a series of articles dealing with problems of jaw movements, articulators, tooth forms, and occlusion.

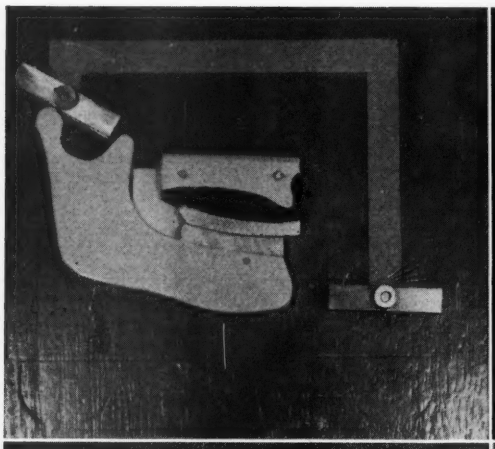


Fig. 1.

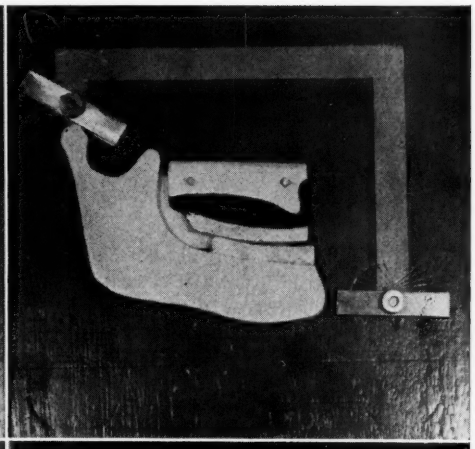


Fig. 2.

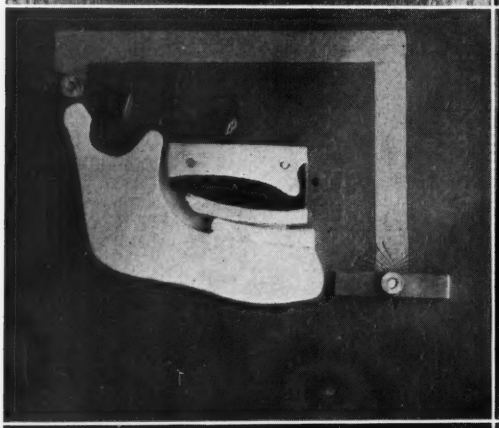


Fig. 3.

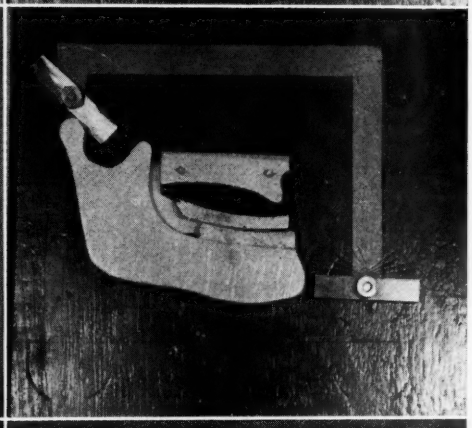


Fig. 4.

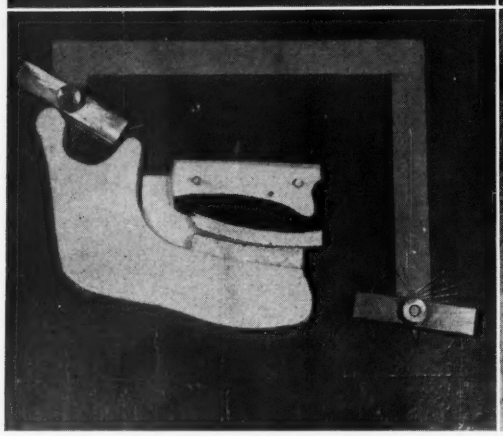


Fig. 5.

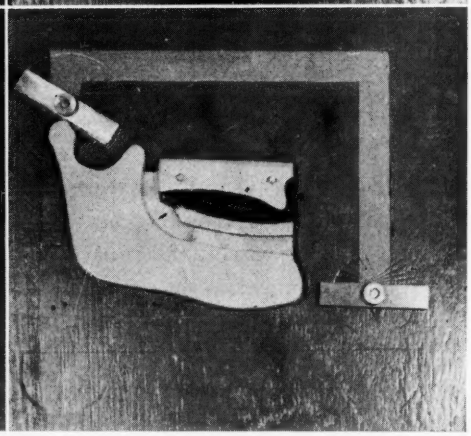


Fig. 6.

Fig. 1.—Plaster and abrasive occlusion rims are used to test the theory of the curved occlusal plane. The protrusive condylar path is set at 30 degrees.

Fig. 2.—A premature contact exists in the posterior portion of the rims, and a space is produced in the anterior portion when a protrusive movement is made.

Fig. 3.—A wider space is created in the anterior portion when the inclination of the condylar path is reduced.

Fig. 4.—A narrower space exists in the anterior portion when the angulation of the condylar path is increased.

Fig. 5.—A space is produced in the posterior portion of the rims after the simulated "chew-in."

Fig. 6.—The rims contact evenly in the protrusive position after the "chew-in."

(Fig. 4). Therefore, when the "chew-in" is made, the separation of the rims in the posterior portion will be smaller.

Protrusive movements were then made to simulate the "chew-in" procedure, and the space was produced in the posterior portion of the rims (Fig. 5). The movements were continued until the rims contacted evenly in the protrusive position (Fig. 6).

Fig. 2.

These tests indicate that curved occlusal planes, regardless of the method by which they are produced, are contraindicated. Cuspless posterior teeth must be arranged by an entirely different technique.

Curved occlusal planes are used because of the prevalent idea that during movement the mandible has a rotational center located somewhere above the occlusal plane. This investigation demonstrates that this is not the case. Normally, during movement of the mandible, its centers of curvature are located somewhere below the occlusal plane.

SUMMARY

A study of curved occlusal planes as developed by the "chew-in" technique or established arbitrarily has been made. Regardless of the method by which they are obtained, curved occlusal planes are contraindicated.

Fig. 4.

REFERENCES

1. Villa A., H.: Mathematical Interpretation of Mandibular Movements, J. Pros. Den. **8**:887-892, 1958.
2. Schweitzer, J. M.: The Transograph and Transographic Articulation, J. Pros. Den. **7**:595-621, 1957.

Bolivar No. 21, Desp. 307
Edificio "San Francisco"
Mexico 1, D. F.

Fig. 6.

CONDYLE PATH TRACER FOR DIAGNOSIS

HONORATO VILLA A., D.D.S.
Mexico, D. F.

AS IN ALL PHASES of the healing sciences, a thorough diagnosis is necessary for the construction of complete dentures. In most instances, only a partial diagnosis has been made with the most important part neglected. The function of the temporomandibular joints in each patient must be known precisely for two main reasons. First, if the function of the joint is known, the articulator that gives the best chance of success can be selected, and, second, according to the difficulties encountered, an estimate of the fee can be made.

An investigation of mandibular function yields a clear idea of: (1) the angle of the condyle path in relation to the plane of orientation, (2) whether this path is straight or curved, and (3) the angulation of the Bennett movement (upward, downward, backward, or forward). These data give the dentist a clearer view of the requisites of denture making, and failures will be less frequent. The data are obtained by means of the condyle path tracer.

METHODS

A metallic plate and a tracer that may be inclined laterally and anteroposteriorly are fixed to an upper impression tray (Fig. 1). A support table with a central bearing screw is fixed to a lower impression tray. Extension bars and a pencil to trace the condyle paths are attached to the table (Fig. 2). Preliminary impressions are made in modeling compound in the impression tray (Figs. 3 and 4).

A card is fixed to the patient's head by means of an elastic band. The condyle or hinge axis is located and the occlusal plane line is traced on the card.

The upper and lower impressions are seated on the ridges, and an approximate vertical dimension of occlusion is established. The tracing pencil is placed on the previously located condyle when the mandible is in centric position. The tracer must be perpendicular to the occlusal table when observed from the front and perpendicular to a line from the condyle to the tracing table when viewed laterally. The patient makes protrusive and lateral movements of the mandible and the condyle paths are traced (Fig. 5).

The cards are cut along the occlusal plane line and the condyle path and are pasted to another card on which the occlusal plane line has been traced. This relates the condyle path to the occlusal plane (Fig. 6). The angle of the Gothic arch (needle-point) tracing is traced in the lower part of the card. It is now possible to determine the approximate angle and curvature of the condyle path (Figs. 6 and 7).

This is the seventh of a series of articles dealing with problems of jaw movements, articulators, tooth forms, and occlusion.

Received for publication June 23, 1958.

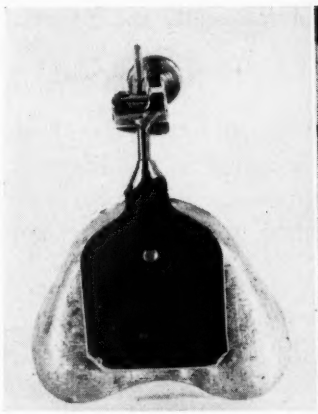


Fig. 1.

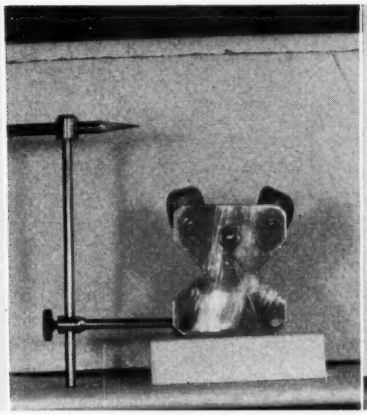


Fig. 2.

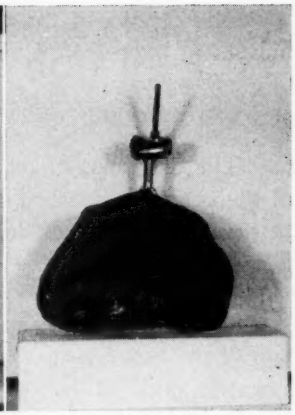
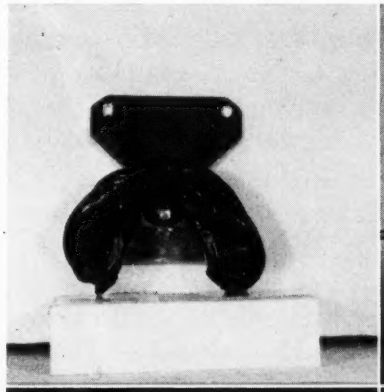


Fig. 3.

Fig. 1.—A metallic plate and tracer are fixed to the upper impression tray.
Fig. 2.—A support table and extension bars are attached to the lower impression tray.
Fig. 3.—A preliminary upper impression is made in modeling compound.

Fig. 4.



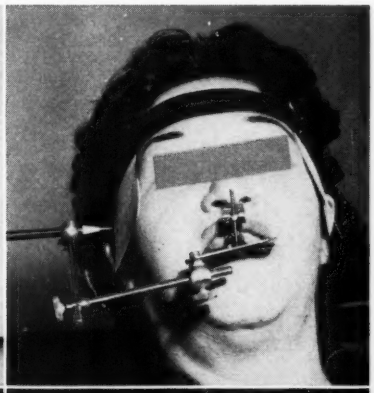


Fig. 5.

Fig. 6.

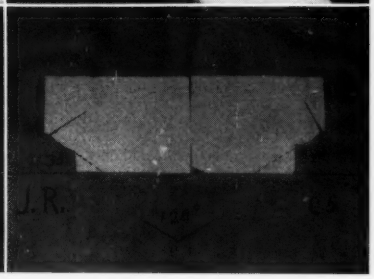


Fig. 7.

Fig. 4.—A preliminary lower impression is made in modeling compound.
Fig. 5.—Cards are fixed to the patient's face by means of an elastic band, and extension bars are placed in position.
Fig. 6.—The condyle path is related to the occlusal plane. The right side condyle path is curved with an approximate inclination of 43 degrees, the diameter of the path is 1½ inches, and the Bennett movement is backward and upward. The left side condyle path is curved with an approximate inclination of 42 degrees, the diameter of the path is 1 inch, and the Bennett movement is backward and horizontal. The Gothic arch tracing is 110 degrees.
Fig. 7.—The right side condyle path is curved with an approximate inclination of 35 degrees, the curvature of the path is 2 inches, and the Bennett movement is backward and upward. The left side condyle path is curved with an approximate inclination of 32 degrees, the diameter of the path is ⅞ of an inch, and the Bennett movement is backward and upward which is diametrically opposed to the condyle protrusive path. The Gothic arch tracing is 120 degrees.

The condyle paths of most patients are curved, and frequently the Bennett movement is backward and upward or downward in relation to the condyle paths.

SUMMARY

The diagnosis of mandibular movements should be included in the diagnosis of the complete denture patient. A means of determining the condyle paths prior to the construction of dentures was explained. The method is simple and is not time consuming.

Bolivar No. 21, Desp. 307
Mexico 1, D. F.

TECHNIQUE FOR ARRANGING POSTERIOR TEETH

HONORATO VILLA A., D.D.S.
Mexico, D. F.

THE ELLIPTICAL PRINCIPLE has made clear some of the obscure concepts of the engineering principles of denture construction. When posterior teeth are arranged for complete dentures, the elliptical principle must be observed to maintain precision in the chain of successive steps.

All of the guiding paths for tooth arrangement are related to the cranium, and all of the moving points that determine the paths are related to the mandible. Therefore, when the posterior teeth are arranged, the paths or cusp inclines must be determined by moving points in the lower member of the articulator. A technique for setting the posterior teeth according to this principle was developed.

PATH TRACER

A path tracer (Fig. 1) was designed which not only traces the paths that will determine the exact position of each posterior tooth but also brings out the deficiencies in incorrectly designed posterior teeth. By means of this tracer, the lateral paths are traced, and the protrusive and working-side inclines are surveyed.

The positions of the posterior teeth are determined by several factors. These are: (1) the height of the occlusal plane, (2) the inclination of the protrusive inclines in harmony with the inclination of the condylar and incisal guides (sagittal plane), (3) the direction of the working-side lateral path, in harmony with the Gothic arch guidances and the balancing-side lateral condyle paths (horizontal plane), and (4) the inclination of the working-side incline, in harmony with the path of the condyle on the working side and the vertical displacement of the incisal guide pin in lateral movement (transverse plane).

ARRANGEMENT OF 33-DEGREE POSTERIOR TEETH

The casts are mounted on the articulator, and the anterior teeth are arranged for esthetics. To comply with the elliptical principle, the upper posterior teeth must be set first with the inclines determined by means of points placed in the lower member of the articulator. The guides on the articulator are adapted according to the posterior teeth used. Pilkington-Turner posterior teeth* were used in this instance.

The path tracer is used to trace the lateral paths on the occlusal surface of the upper occlusion rim. The path tracer is placed firmly on the lower rim with the

---

This is the eighth of a series of articles dealing with problems of jaw movements, articulators, tooth forms, and occlusion.

Received for publication July 7, 1958.

*The Dentists' Supply Co. of New York, York, Pa.

occlusal tracing points directed upward (Fig. 2). The articulator is closed in centric position (Fig. 3), and a lateral movement is made. Tracings are made farther back until four paths have been traced on the occlusal surface of the upper rim. One of the paths is extended by means of a ruler to preserve it as a future reference (Fig. 4).

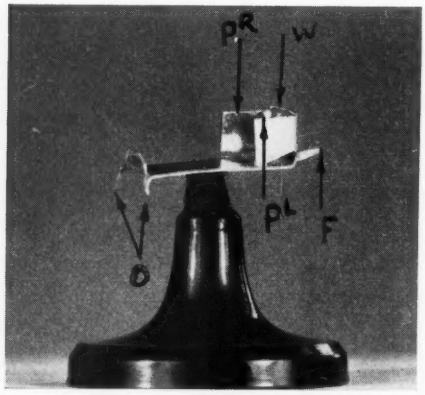


Fig. 1.

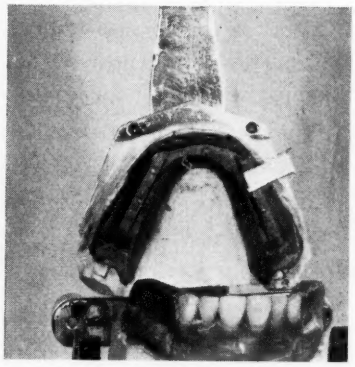


Fig. 2.

Fig. 1.—A path tracer is used to determine the exact position of each posterior tooth. *P*, The protrusive surveyors (*R*—right, *L*—left). *W*, The working incline surveyor. *O*, The occlusal tracing points. *F*, The fixing points.

Fig. 2.—The path tracer is in position for tracing the lateral paths on the occlusal surface of the upper occlusion rim.

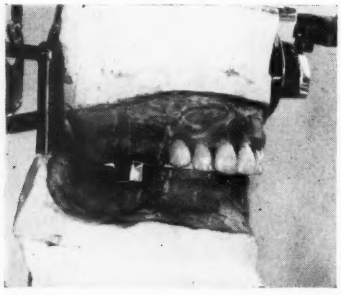


Fig. 3.

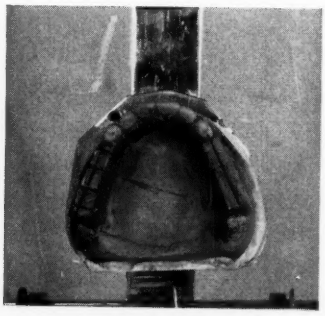


Fig. 4.

Fig. 3.—The articulator is closed in centric position and a lateral movement is made.

Fig. 4.—Four paths are traced on the occlusal surface of the upper occlusion rim. One path is extended onto the palate to be used for future reference.

A small section of wax is removed from the upper occlusion rim to facilitate the placement of the first bicuspid. A line is traced from the tip of the buccal cusp to the tip of the lingual cusp, and this line is made parallel with the path traced in the wax in back of the bicuspid. The lingual cusp of the bicuspid is placed at the height of the occlusal plane.

With the articulator closed in centric position, the path tracer is positioned on the buccal surface of the lower occlusion rim to survey the protrusive and

working-side inclines of the upper first bicuspid. A soft wax may be placed on the buccal surface of the lower occlusion rim so that the path tracer may be positioned easily. The protrusive surveyor is placed in contact with the distal angle of the bicuspid, and the working surveyor is placed in contact with the working incline (Fig. 5). Some teeth have a small deep groove in the center of the occlusal surface which must not be engaged by the working surveyor. The surveyor must be placed on the straight portion of the inclines.

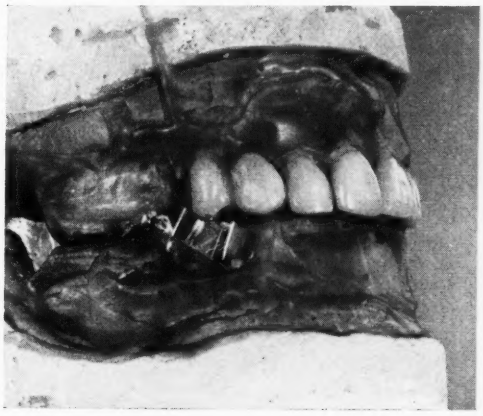


Fig. 5.—The path tracer is in position for surveying the protrusive and working-side inclines.

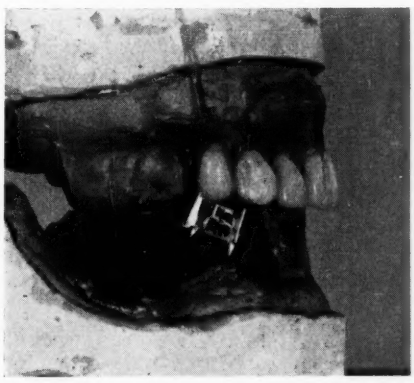


Fig. 6.

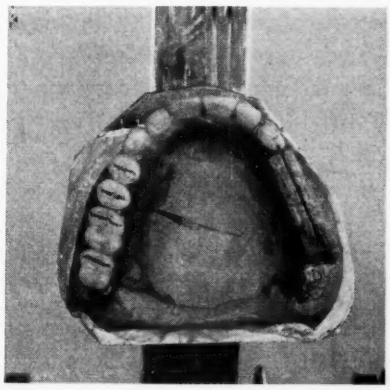


Fig. 7.

Fig. 6.—The articulator is in the working position. The working incline is adjusted to follow the edge of the attachment closely.

Fig. 7.—The occlusal line of the first and second molars parallels the occlusal path.

The articulator is moved to the working position, and the working incline of the upper first bicuspid is adjusted to follow the edge of the attachment (Fig. 6). Then the articulator is moved to the protrusive position, and the protrusive incline is adjusted to follow the edge of the protrusive surveyor.

The upper second bicuspid is placed in position with the occlusal line between the tips of the buccal and lingual cusps parallel with the occlusal path. The mesial marginal ridge of the second bicuspid is adjusted at the same height as the distal marginal ridge of the first bicuspid. The working and protrusive inclines are surveyed in a similar manner as described.

The upper first and second molars are placed, respectively, with the occlusal line parallel to the occlusal paths (Fig. 7) and the mesial marginal ridge at the height of the distal marginal ridge of the tooth in front. The working and protrusive inclines are surveyed again. The correct compensating curve is established automatically.

The lower posterior teeth are set in position. They should go to place correctly (Fig. 8), and the occlusion will be balanced.

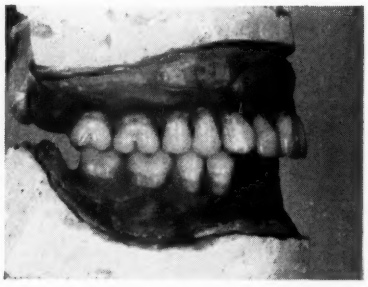


Fig. 8.—The lower posterior teeth are in centric occlusion with the upper posterior teeth.

Some corrections must be made in the occlusion because available stock denture teeth have been designed according to a principle different from the actual mandibular movement. Teeth designed according to the elliptical principle could be arranged easier and with more precision.

It is not logical to base the design of a tooth on a curve from an empirical center of rotation and arrange this tooth in relation to a flat plane by means of an empirical technique. The design of the tooth and the method of its arrangement should be based on the same principle.

The technique described gives the correct inclination of the cusp inclines for each patient. However, the combination of the several factors of tooth arrangement may produce marked differences in these inclines. Therefore, no standard or empiric method of arranging the posterior teeth is equally applicable to all patients.

ARRANGEMENT OF 20-DEGREE POSTERIOR TEETH

The 20-degree posterior teeth are designed using the same principle as the 33-degree posterior teeth. Therefore, there is no difference in the technique of arranging 20-degree posterior teeth from the technique of arranging the 33-degree posterior teeth.

The working-side incline of the bicuspids is very short and the inclination very small which makes it difficult to follow this incline with the surveyor, especially in

the smaller molds. Even though surveying is possible, to save time and work, the first bicuspid is set with the buccal cusp at the same level as the occlusal plane and the lingual cusp is raised slightly from this plane. The second bicuspid is set with both cusps at the same level as the occlusal plane.

The working-side incline of the first and second molars can be seen clearly and is followed with the surveyor in the manner described for the 33-degree molars. The protrusive inclines are determined also in the method described for the 33-degree posterior teeth. However, because of differences in the inclination of the condylar and incisal guides, the protrusive inclines have different inclinations.

It is obvious that corrections must be made in the occlusion after the denture has been processed. However, these corrections are small when compared to the corrections needed when the teeth are arranged by the usual empirical method.

A scientific principle is needed to develop the occlusal surfaces of posterior teeth so that they are in harmony with the inclination of the guides in the articulator. This same principle should be applied to correctly position the occlusal surfaces of artificial teeth. If the posterior teeth are arranged according to the paths reproduced in an articulator, balanced occlusion is obtained without extensive grinding on the occlusal surfaces.

From this technique, the conclusion that only correctly designed teeth can be correctly arranged is reached.

ARRANGEMENT OF NONANATOMIC POSTERIOR TEETH

There are several different designs of nonanatomic posterior teeth, but they all have flat contacting occlusal surfaces. Also, there are several different techniques for arranging this kind of teeth. However, none of these procedures adjust themselves to any true scientific principle.

Flat posterior teeth are preferred by some dentists because as the ridges gradually resorb and the vertical dimension of occlusion is shortened, the chin swings upward and forward, which places the lower denture in a forward relation to the upper denture. When cusp teeth are used, the relation of the lower to the upper occlusal surfaces will be altered. Thus, cuspal interference is produced which brings about a more rapid resorption of the ridges. Those who favor the use of flat posterior teeth feel that because the teeth are flat, the lower denture can be in a forward position without cuspal interference and balanced occlusion can be maintained. This theory is not true, and there are no scientific data to confirm it.

A denture should not maintain, require, or permit the mandible to be in an abnormal position. The relation of the mandible to the maxillae and to other related structures should be the same as that which existed when the patient had a full complement of natural teeth so that the functions of mastication, phonetics, etc. may be performed normally.

If the vertical dimension of occlusion has been shortened, the muscles of mastication must contract further than their optimal working length to bring the dentures into contact. This excessive contraction prevents the muscles from performing their function normally. The dentures must be checked periodically, and correct occlusal relations re-established when necessary.

I do not accept the statement that the balanced occlusion of nonanatomic teeth is unaltered when the mandible swings forward as a result of the ridge resorption. To maintain balanced occlusion, it would be necessary that bony resorption take place in a definite equal pattern in all parts of the ridges. Because of the special structure of the bone in the ridges and the different thickness of this bone, resorption is apt to occur in some regions more quickly or more extensively than in other regions.

Anatomic or nonanatomic teeth in themselves are not harmful; it is the way in which they are used that is harmful. The deficiences in the use of cusp teeth are applicable also to cuspless teeth because there is not a single technique by which lateral balancing contacts may be obtained.

All of the occlusal surface (transversely) of nonanatomic teeth becomes a working incline, and its position should be determined with precision according to all factors of balanced occlusion. The balancing contacts are obtained on the second molar. Therefore, all of the length of the occlusal surface anteroposteriorly becomes a protrusive incline, and the direction of this incline must be obtained with precision. If lateral balancing contacts are to be obtained, the registration of the mandibular movements and their reproduction on an articulator must be made with precision whether cusp or cuspless teeth are used.

One of the most widely spread ideas is that the requirements of the articulator are very simple when cuspless teeth are used. Nothing is farther from the truth. These techniques are carried out often on very inadequate instruments, and the requirements of the articulator are the same whether cusp or cuspless teeth are used.

It was demonstrated previously[1] that curved occlusal planes are contraindicated when using cuspless teeth.

CONCLUSIONS

A complete revision and evaluation is needed in the specialty of prosthodontics. The elliptical theory, unlike any other, may be proved experimentally and mathematically and is compatible with all the steps in denture construction. It is consistent throughout and aids in the logical determination of the different factors of balanced occlusion.

The lack of a scientific principle has led to the creation of a number of empirical "short-cut" techniques not only in the arrangement of teeth but also in the design of articulators and in the design of the occlusal surfaces of posterior teeth. The number of complete denture failures is not surprising when the many factors that do not answer to a scientific principle are considered.

These problems of occlusion will not be solved by "short-cut" techniques that are not scientific. We must start with the study of the muscles of mastication, determine how these muscles activate the temporomandibular joints, analyze the pattern of movement, and express a theory. The theory must be proved beyond any doubt experimentally and mathematically, and when proved correct, it should be applied to the teaching methods, the relation of the different factors of occlusion, the design of registering instruments and articulators, and the problems of occlusal

surfaces of posterior artificial teeth, the setting of the posterior teeth and correction of the occlusion, and the maintenance of the denture.

The technique of arranging teeth which was described is consistent with the principles of the elliptical theory.

REFERENCE

1. Villa A., H.: Curved Occlusal Planes are Contraindicated, J. Pros. Den. **9**:797, 1959.

Bolivar No. 21, Desp. 307
Mexico 1, D. F.

THE ADAPTABILITY OF POSTERIOR TEETH

HONORATO VILLA A., D.D.S.
Mexico, D. F.

MANDIBULAR MOVEMENTS ARE NOT reversible because of their elliptical character. The available posterior teeth were carved using an articulator of conventional design with reversed movement. Therefore, not only were the deficiencies of design not corrected but another error was incorporated in the occlusal pattern.

The range of adaptability of anatomic posterior teeth was studied using only the first molars. The upper first molar was determined to be in the correct position in each test by the use of a path tracer to check the protrusive and lateral paths. The protrusive paths were traced on the lower occlusion rim according to the way the teeth were designed. A special path tracer was used to trace the paths for the 20-degree posterior teeth (Fig. 1). The Gothic arch guidance was set at 120 degrees, the lateral condylar guidance at 15 degrees, the horizontal condylar guidance at 30 degrees, and the incisal guidance (protrusive) was set at 10 degrees. The tests were made on a Gysi Trubyte articulator.

METHODS OF PROCEDURE

The protrusive paths were traced on the lower wax test rim (Fig. 2). Then the upper first molar was positioned with the protrusive inclines parallel to the tracings on the lower test rim (Fig. 3) and the occlusal lateral paths parallel to the tracing on the rim (Fig. 4). The inclination of the working incline was surveyed with the path tracer to be sure that the position was correct (Fig. 5).

With the guides of the articulator left at the same inclinations, the Gothic arch guidance was changed to 100 degrees, and the first molars were placed in the correct position. The rotation of the molar needed to place the lateral path of the tooth in correct relation with the lateral path of the articulator is shown in Fig. 6. It would be extremely difficult to arrange a full complement of posterior teeth with this rotation. Even though the teeth are in correct positions for a working occlusion,

---

This is the ninth of a series of articles dealing with problems of jaw movements, articulators, tooth forms, and occlusion.
Received for publication July 7, 1958.

Fig. 1.—The path tracer is in position to trace the protrusive paths.

Fig. 2.—The protrusive paths are traced on the buccal surface of the lower test rim.

Fig. 3.—The upper first molar is positioned so that the protrusive inclines are parallel to the tracings on the lower rim.

Fig. 4.—The occlusal lateral paths are parallel to the occlusal tracing.

Fig. 5.—The working path is surveyed with the path tracer.

Fig. 6.—The correct occlusal position of the first molar is determined when the Gothic arch guidance is 100 degrees.

Fig. 1.

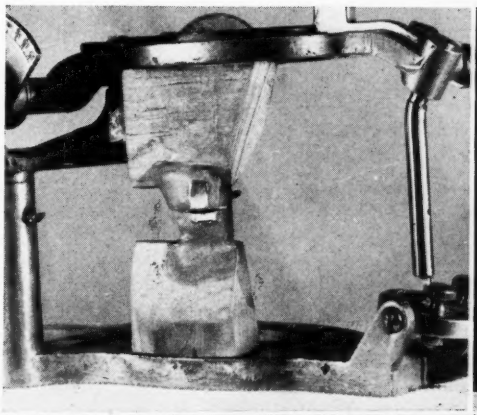


Fig. 2.

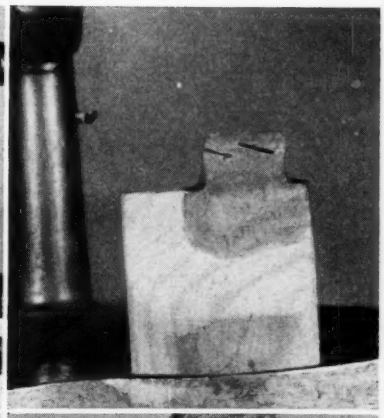


Fig. 3.

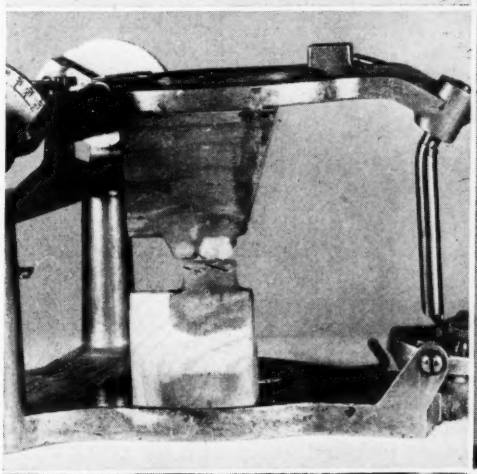


Fig. 4.

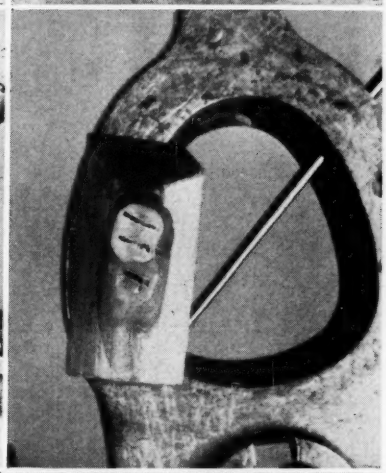


Fig. 5.

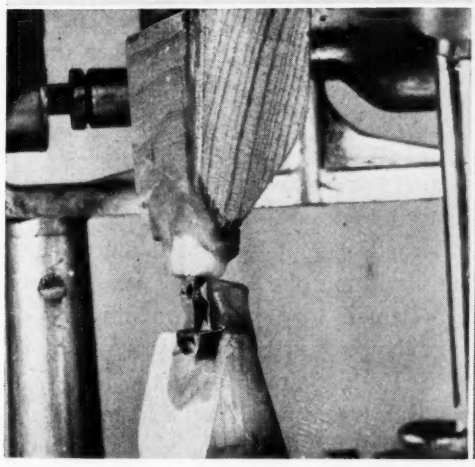
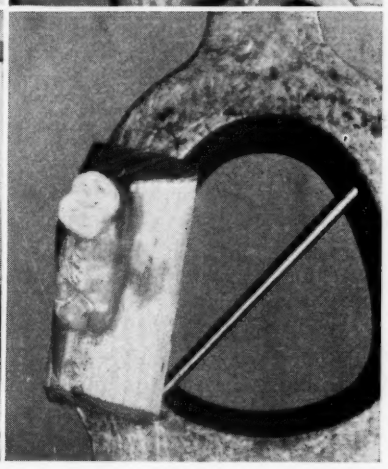


Fig. 6.



Figs. 1 to 6.—*For legends, see facing page.*

there is not enough cusp height to obtain contact between the lingual cusps (Fig. 7). The same thing happens to the contacts on the balancing side (Fig. 8). There is not enough cusp height because the working-side incline needs more inclination. When the tooth is tilted to this inclination, the lingual cusps will not have sufficient inclination to make contact. Therefore, a different design of posterior teeth is needed to overcome these difficulties.

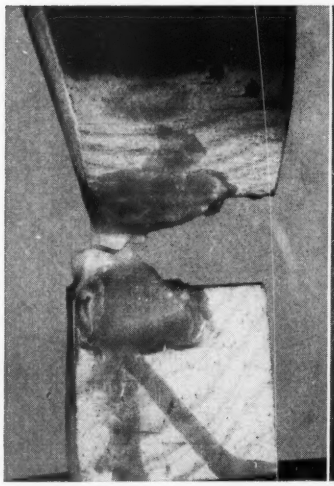


Fig. 7.

Fig. 8.

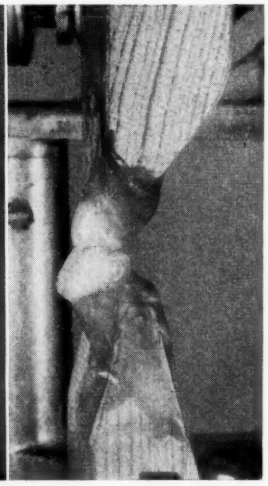


Fig. 9.

Fig. 7.—The lingual cusps do not contact when the Gothic arch guidance is 100 degrees.
Fig. 8.—There is not enough cusp height on the balancing side to establish contact. The Gothic arch guidance is 100 degrees.
Fig. 9.—A poor esthetic effect is obtained when the Gothic arch guidance is 140 degrees.

The Gothic arch guidance was changed to 140 degrees with the other articulator adjustments unchanged. The first molars were set in centric position. This arrangement needed a slight inclination of the working incline. However, when this incline was properly placed, the buccolingual inclination of the teeth was exaggerated and resulted in a poor esthetic effect (Fig. 9).

These deficiencies are detected only when using a precise technique of arranging teeth and are found in Pilkington-Turner* and other types of anatomic posterior teeth. Therefore, it is not possible to adapt one design of teeth within the range of movements of Gothic arch guidances. A tooth cannot be rotated more than 5 degrees to either side, which means a total variation of 10 degrees is the maximum.

The only logical solution to the problem is to develop two different designs of posterior teeth, one for a Gothic arch guidance of 110 degrees that will be adaptable to Gothic arch tracings of from 100 to 120 degrees, and another design of 130 degrees that will be adaptable to Gothic arch tracings of from 120 to 140 degrees. This plan would eliminate the necessity of extensive grinding and destruction of the occlusal surfaces when the teeth are adapted to each individual. The teeth should be designed to the specifications shown in Table I.

*The Dentists' Supply Co. of New York, York, Pa.

CONCLUSIONS

For the majority of patients and for better stability, the 20-degree tooth is best. However, a higher cusp tooth is indicated for patients who have steep condylar inclinations. The designs must be modified in the Gothic arch angle.

It is not possible to design a posterior tooth that will adapt itself to all patients without extensive grinding. The deficiencies of the teeth now available make it evident that a different design for posterior teeth must be developed.

TABLE I. SUGGESTED SPECIFICATIONS FOR DESIGNS OF POSTERIOR TEETH

	20-DEGREE POSTERIOR TEETH*		33-DEGREE POSTERIOR TEETH	
	A (DEGREES)	B (DEGREES)	A (DEGREES)	B (DEGREES)
Horizontal condylar inclination	30	30	30	30
Lateral condylar inclination	15	15	15	15
Incisal inclination	10	10	30	30
Gothic arch guidance	110	130	110	130

*Two different designs are suggested for both 20- and 33-degree posterior teeth. *A*, The Gothic arch guidance is 110 degrees. *B*, The Gothic arch guidance is 130 degrees. The incisal inclination is 10 degrees for the 20-degree posterior teeth and 30 degrees for the 33-degree posterior teeth.

Gysi's theory of tooth design is not based on a scientific principle, and the deficiencies of the teeth now available are partly due to this fact. In the process of carving posterior teeth, empirical adjustments are necessary to compensate for this error. The posterior teeth must be designed in such a manner that their true position may be obtained with scientific and precise arranging techniques.

To obtain a correct design of the occlusal surface of posterior teeth, an entirely different and scientific technique must be used. The teeth must be carved on an articulator in which the guides are related correctly to one another.

BOLIVAR NO. 21, DESP. 307
MEXICO 1, D. F.

DESIGN OF POSTERIOR TEETH

HONORATO VILLA A., D.D.S.
Mexico, D. F.

THE DESIGN OF POSTERIOR TEETH and the technique of their arrangement must have the same principle. Each of the tooth inclines must be determined accurately and surveyed for precision. When this is done, the actual difficulty of designing the posterior teeth by one arbitrary principle and arranging them by a different arbitrary principle is eliminated.

As a final corroboration of the elliptical theory, plaster posterior teeth were carved to prove that the occlusal surfaces could be made in a precise and scientific way. The cutting blades, so carved, had to be made at least three times the natural size so that precise surveying and carving could be done.

There were no empirical steps in this technique. All phases were developed with precision so that the carving was made to the desired specifications.

All things that suggest that the rotational center is somewhere above the guides of the articulator were eliminated in these tests.

PROCEDURES

The width of each tooth was obtained from a cast of the teeth of a young girl. The teeth were fairly normal with no cavities or malocclusion. The measurements were amplified to three times their natural size by means of a special instrument.

The protrusive inclines were determined by mathematical means, and the compensating curve was related to the horizontal plane (Fig. 1). The height of the lingual cusps was determined by the same precision method (Fig. 2). The points of contact of the working and balancing inclines at the central groove were also determined (Fig. 3).

All of the data were transported to a horizontal drawing to determine the occlusal pattern of the cutting blades (Fig. 4), and the design was reproduced on a metal plate (Fig. 5). Cutting blades that were machined to precision were fixed on this plate (Fig. 6). The blades were placed in the articulator, and preliminary carvings were made (Fig. 7). Then the final anatomic details were incorporated in these carvings (Fig. 8).

The occlusal surfaces would have to be made in metal and reduced to the desired sizes in a three-dimensional pantograph to complete the construction of the artificial teeth.

This is the tenth of a series of articles dealing with problems of jaw movements, articulators, tooth forms, and occlusion.

Received for publication July 7, 1958.

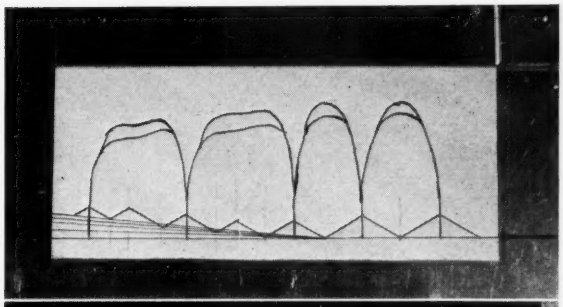


Fig. 1.

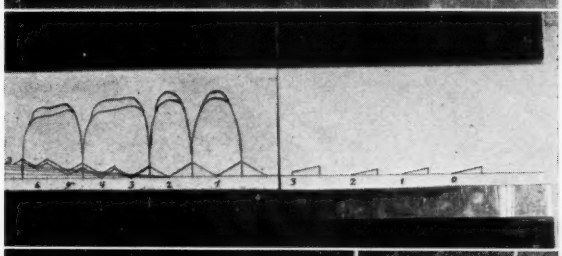


Fig. 2.

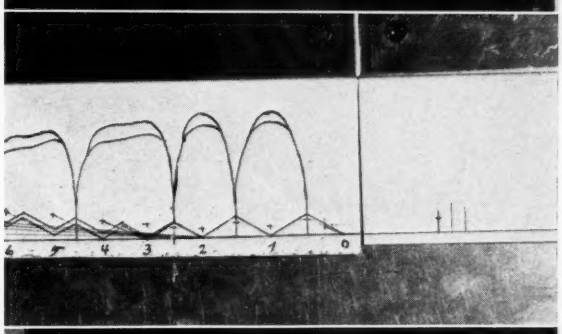


Fig. 3.

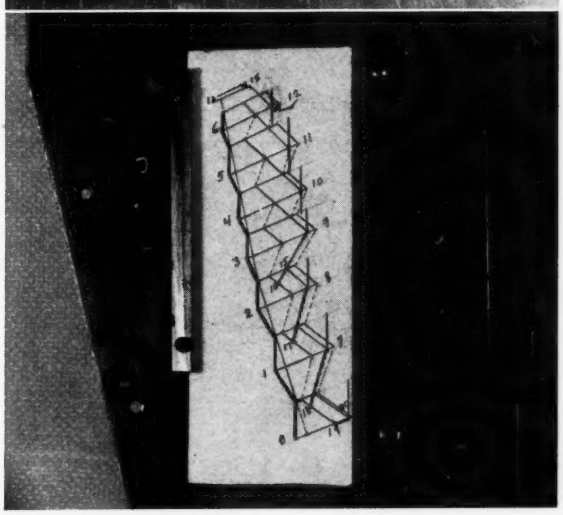


Fig. 4.

Fig. 1.—The compensating curve is related to the horizontal plane.

Fig. 2.—The height of the lingual cusps is determined by mathematical means.

Fig. 3.—The height of the points where the working and balancing inclines meet at the central groove is determined.

Fig. 4.—The occlusal pattern of the cutting blades has been determined by means of a drawing.

Fig. 5.

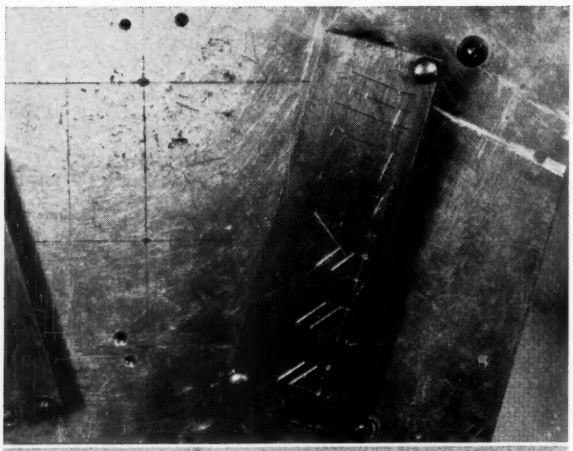


Fig. 6.

Fig. 7.

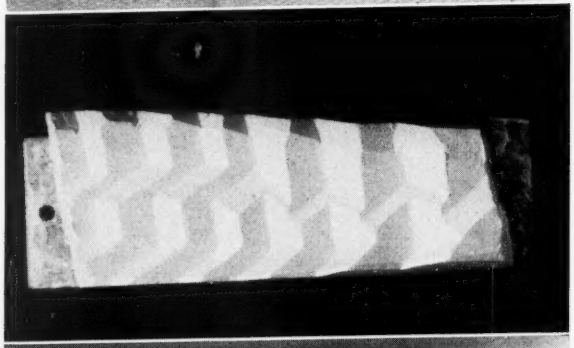


Fig. 8.

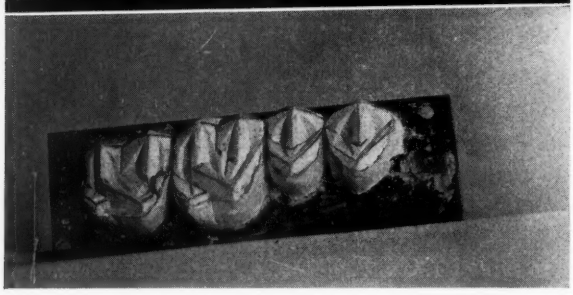


Fig. 5.—The occlusal design is reproduced on a metal plate.
Fig. 6.—The cutting blades are machined to precision and fixed on the metal plate.
Fig. 7.—Preliminary carving in plaster.
Fig. 8.—Final carving of the upper posterior teeth.

CONCLUSIONS CONCERNING THE ELLIPTICAL THEORY

The study of the elliptical theory was made in an attempt to reduce the possible causes of error in denture construction to a minimum. The frictional stresses produced by the reversal of the movements in conventional articulators have been reduced considerably, and I believe that the periodic reconditioning of the denture due to the destruction of the supporting structures will be less frequent. All the necessary equipment for this work, including the articulator, has been developed. This study suggests a new avenue of thought for further research.

There are other factors in denture construction which require precise methods for their control. Among these are: a precise method for determining the vertical dimension of occlusion and the buccolingual position of the lower posterior teeth. These teeth should be placed in the same position that the natural teeth occupied. The position of the natural teeth was determined by the functional action of the muscles of the tongue and the muscles of the cheek. The equilibrated action of these groups of muscles should prove to be a stabilizing factor on lower dentures. If the teeth are not positioned correctly, one of the associated groups of muscles becomes a disturbing factor. A technique for determining the position of these teeth is needed.

Finally, a denture base material that will not suffer volumetric changes in the processing and postprocessing stages is needed. These changes are harmful to the accuracy of our work.

Bolivar No. 21, Desp. 307
Mexico 1, D. F.

ELIMINATING A HEALTH HAZARD IN PROSTHODONTIC TREATMENT OF PATIENTS WITH PULMONARY TUBERCULOSIS

M. A. Pleasure, D.D.S., M.S.P.H.,* Edith L. Duerr, Ph.D.,** and Milton Goldman, B.S.**

Bronx Veterans Administration Hospital, Bronx, N. Y.

The construction of dentures for tuberculous patients presents a special hazard. Impressions, jaw relation registration apparatus, try-ins, etc., are exposed to contamination in the patient's mouth and cannot be sterilized by heat. Wax, shellac baseplates, acrylic resin, etc., are all thermoplastic materials and would be destroyed or distorted by usual sterilizing methods. After use in the patient's mouth, they must be returned to the dental laboratory where technicians cannot take aseptic precautions. For example, the wearing of rubber gloves is impracticable and may present a physical hazard at the polishing lathe. Therefore, we undertook to establish a reliable method of sterilizing all such materials and appliances after exposure in the patient's mouth and before transferring them to the dental laboratory.

EFFECT OF SEVERAL GERMICIDES UPON RELEVANT DENTAL MATERIALS

We considered chemical vapors, solutions, and ultraviolet light as possible germicides for dental materials. Since ultraviolet light is effective only upon exposed surfaces, areas in "shadows" or in deep crevices, creases, or wrinkles are not reached by direct rays and sterilization is uncertain. Chemical vapor, specifically formaldehyde, was tried first but abandoned in favor of a solution which offered greater security. Seventy per cent alcohol, 5 per cent Lysol, and formalin 1, 5, and 10 per cent were the solutions tested.

Because of the danger of deformation and dissolution, our first tests determined the physical and chemical effects of germicides upon the dental materials themselves. The dental materials tested and the effects of several germicides are presented in Table I. Seventy per cent alcohol and 5 per cent Lysol showed undesirable effects upon several dental materials and, therefore, their study was not continued. Formaldehyde solutions seemed harmless to the dental materials subjected to their action.

Received for publication Oct. 23, 1958.

*Chief, Dental Service.

**Microbiology Section.

TABLE I

DENTAL MATERIALS TESTED	GERMICIDES				
	70 PER CENT ALCOHOL	5 PER CENT LYSOL	1 PER CENT FORMALIN	5 PER CENT FORMALIN	10 PER CENT FORMALIN
Baseplate wax, hard	N. C.*	N. C.	N. C.	N. C.	N. C.
Utility wax, soft	N. C.	N. C.	N. C.	N. C.	N. C.
Dental stone, yellow	N. C.	Soapy film	N. C.	N. C.	N. C.
Laboratory plaster, white	N. C.	Soapy film	N. C.	N. C.	N. C.
Impression compound, red (Kerr)	Softened, deteriorated	Surface attacked	N. C.	N. C.	N. C.
Impression compound, green (Kerr)	Softened, deteriorated	Surface attacked	N. C.	N. C.	N. C.
Shellac baseplate, single, pink	Dissolved	Color bleached, softened	N. C.	N. C.	N. C.
Zinc-oxide-eugenol impression paste (Coeflo)	Color change to gray	Not tested	Not tested	Not tested	N. C.
Rubber impression paste (Kerr Permlastic)	Color change, bleached	Bleached, softened, deteriorated	N. C.	N. C.	N. C.
Self-curing acrylic resin, fast (Getz Oryl) (60 min.)	N. C.	Not tested	Not tested	Not tested	N. C.
Acrylic resin denture base material	No visible change (not advisable)	Surface softened	N. C.	N. C.	N. C.

All materials were inspected after 1, 2, 4, and 24 hours.

***N. C. = no change.**

GERMICIDAL EFFECTIVENESS TESTED UPON DENTURE IMPRESSIONS SEEDED WITH MYCOBACTERIUM TUBERCULOSIS

Our routine impression procedure involves the construction of slightly oversized individual impression trays made of double-thick shellac baseplates upon preliminary casts. These trays are border molded with green stick compound, and then a final impression is made in a self-curing thiokol rubber paste (Kerr Permlastic, medium set). Such impressions achieve several results: (1) the attached bearing mucosa is registered in its undeformed state for maximum stability and comfort of the denture base, (2) the border tissues are displaced to a physiologically tolerable degree to achieve a border seal and added retention, and (3) the impression material can be stripped out *instantly* without injury to the tray if the impression fails to meet our standards.

Because they contain the materials most susceptible to chemical attack, a number of such impressions were recovered from the final casts in good condition for purposes of our tests. The shellac trays were broken up into several large pieces, and the adherent film of the rubber impression material was cut with scissors on the lines of fracture. Thirty pieces of impression thus prepared, composed of shellac baseplate, green Kerr modeling compound, and Kerr Permlastic rubber, were immersed in Zephiran chloride 1:1,000 and allowed to soak overnight to minimize bacterial flora.

The pieces of impression were removed from the Zephiran chloride with sterile forceps, rinsed in two successive boats of sterile distilled water, and placed in a third boat to dry in the incubator at 37° C.

SEEDING OF IMPRESSION MATERIALS

A heavy suspension of a human strain of *Myco. tuberculosis* freshly isolated from sputum was prepared in 4 ml. of tuberculosis broth* with plasma and dextrose. This plus 30 ml. of restored human plasma was added to 550 ml. of sterile saline solution and well shaken. The organism suspension in 5 per cent plasma saline was transferred into a deep sterile dish, and the impression samples were immersed in this suspension for 15 minutes. The samples were then removed with sterile forceps placed into sterile boats and allowed to air dry in the hood for one hour at room temperature. The impression samples were placed in the test material for specified times and then placed in two saline rinses.

The following nine jars (labeled *A-I*) were set up for the test. After drying for an hour, three pieces of seeded impression were transferred aseptically from the boats directly to sterile tuberculosis broth culture medium *(A)*. Six pieces of seeded and air-dried impression samples were transferred to sterile saline solution. Three were removed after 5 minutes *(B)*, and three after 15 minutes *(C)*. Each sample was passed through two saline rinses and cultured in tuberculosis broth.

*Composition of tuberculosis broth: tuberculosis broth base (Difco), 17.4 Gm; glycerin, C.P., 150.0 ml.; distilled H_2O, 1,500.0 ml. Autoclave for 15 minutes at 15 pounds pressure. Cool to 45° C. Aseptically add: 50 per cent sterile dextrose, 17.5 ml.; reconstituted human plasma, 175.0 ml. Dispense aseptically in 50 ml. aliquots into sterile 8 ounce screw-cap jars. Incubate jars for 24 hours to check for sterility.

Nine similar pieces of seeded impression samples were placed into 10 per cent formalin solution. Three pieces were removed in 5 minutes *(D)*, three in 10 minutes *(E)*, and three in 15 minutes *(F)*. Upon removal from formalin, each sample was passed through two rinses of sterile saline and then cultured in tuberculosis broth.

TEST MATERIALS[1]		SALINE RINSE 1	SALINE RINSE 2
Saline	500 ml.	500 ml.	500 ml.
*Forma-San	500 ml.	500 ml.	500 ml.
10 per cent formalin	500 ml.	500 ml.	500 ml.

*Forma-San is manufactured by Huntington Laboratories, Huntington, Ind., and contains isoproply and methyl alcohols, formaldehyde, benzalkonium chloride, methyl-bis-trichlorphenol, 51 per cent; sodium nitrite 1 per cent; and water 48 per cent. This germicide was tested because previous trials with cystoscopes had proved it to be one of the more effective agents.[1,2]

TABLE II. ACID FAST BACILLI IN CORDS

A	Positive control	1	G
		2	G
		3	G
B	Saline control, 5 minutes	1	G
		2	G
		3	G
C	Saline control, 15 minutes	1	G
		2	G
		3	G
D	Formalin 10 per cent, 5 minutes	1	G
		2	G
		3	G
E	Formalin 10 per cent, 10 minutes	1	G
		2	G
		3	G
F	Formalin 10 per cent, 15 min.	1	G
		2	N
		3	N
G	Forma-San, 5 minutes	1	G
		2	G
		3	G
H	Forma-San, 10 minutes	1	G
		2	G
		3	G
I	Forma-San, 15 minutes	1	G
		2	G
		3	N

G = growth.
N = negative.

Nine pieces of impression samples were placed in Forma-San and treated thereafter like the samples in the 10 per cent formalin *(G, H, I)*.

A quantitative study was made to establish a reliable estimate of the number of viable *Myco. tuberculosis* organisms in the suspension from which impression

samples were seeded. It was determined that 1 ml. of suspension contained in excess of 400,000 viable *Myco. tuberculosis* organisms.

To eliminate the possibility of extraneous contamination during seeding, sterility tests were run of all rinsing solutions and containers, using Thioglycolate medium. This medium will grow almost all bacteria but not *Myco. tuberculosis.* No growth appeared in 48 hours.

Results of this experiment are shown in Table II. All cultures were positive except two of the three exposed to 10 per cent formalin for 15 minutes and one of the three exposed to Forma-San for 15 minutes. The impressions which had been immersed in Forma-San for 15 minutes showed signs of physical deterioration. Because of this and because 10 per cent formalin was cheaper and probably more effective, all later studies were confined to 10 per cent formalin, U.S.P.*

REPEAT TESTS

Experience and observation had made us aware of a factor that may have influenced our results in an uncontrolled manner. The chemical composition of

TABLE III

			GROWTH TESTED (DAYS)		
			7	24	49
A	1	Positive	+	+	
	2	Controls	−	+	
	3		+	+	
B	4	Saline, 15 minutes,	−	+	
	5	plus 2 sterile	+	+	
	6	saline rinses	+	+	
C	7	Saline, 30 minutes,	−	+	
	8	plus 2 sterile	−	−	+
	9	saline rinses	−	+	
D	10	Saline, 1 hour,	−	+	
	11	plus 2 sterile	−	+	
	12	saline rinses	−	+	
E	13	10 per cent formalin, 15 minutes,	−	−	−
	14	plus 2 sterile	−	−	−
	15	saline rinses	−	−	−
F	16	10 per cent formalin, 30 minutes,	−	−	−
	17	plus 2 sterile	−	−	−
	18	saline rinses	−	−	−
G	19	10 per cent formalin, 1 hour,	−	−	−
	20	plus 2 sterile	−	−	−
	21	saline rinses	−	−	−

the thiokol rubber is not known to us. It may contain materials toxic or inhibitory to growth of *Myco. tuberculosis.*

*Ten per cent formalin can be prepared by adding 270 ml. of water to 100 ml. of 37 per cent formaldehyde to make 370 ml. of solution containing 37 Gm. of active HCHO.

Therefore, we decided to repeat our tests with certain precautions. The jars containing inoculated samples of test impressions were shaken up, and the test impressions were removed aseptically from the medium after the first 48 hours of incubation. This reduced the possibility of bacteriostasis resulting from prolonged presence of thiokol rubber in the medium. In addition, we extended the period of exposure to the germicide to include periods of 30 and 60 minutes.

RESULTS

Table III shows the results of the repeat tests. They may be summarized according to materials as: *A,* Two out of three positive controls showed growth in 7 days and all in 24 days. *B,* Two out of three seeded impression samples exposed to sterile saline for 15 minutes showed growth in 7 days and all in 24 days. *E,* Of three seeded samples exposed to 10 per cent formalin for 15 minutes, all were negative at the end of 49 days. *F,* Samples exposed to 10 per cent formalin for 30 minutes, as well as, *G,* for one hour showed no growth in 49 days, whereas of similar samples exposed to saline solution for the same periods the majority showed growth in 24 days, and all showed growth within 49 days.

All negative broth cultures were transferred to centrifuge tubes and spun at 2,500 r.p.m. for 30 minutes. The supernatant was discarded and the sediment was planted in triplicate on Lowenstein's medium. Nine weeks' incubation showed all tubes to be negative.

CONCLUSIONS

Several complex organic dental materials used in our impression technique showed no injurious effects upon prolonged exposure to 10 per cent formalin solution. Seventy per cent alcohol attacked both shellac baseplate and impression modeling compound, while Forma-San produced softening and other changes in the thiokol rubber impression paste.

Impression samples heavily seeded with *Myco. tuberculosis* were effectively sterilized by immersion in 10 per cent formalin solution for 15 minutes. For further security, we have adopted 30 minutes of immersion as minimal standard for sterilizing impressions, jaw relation registration components, try-ins, stone and plaster casts, etc., before they are turned over to the laboratory technician. They are then copiously rinsed in cold running water to remove irritating formalin.

SUMMARY

Prosthetic dental treatment of the tuberculous patient presents some special hazards and problems in preventing exposure of dental personnel to infection. Several possible germicides cannot be used because they produce undesirable changes in complex organic dental materials. Immersion of sample impressions heavily seeded with *Myco. tuberculosis* in 10 per cent formalin solution for 30 minutes has no deleterious effect upon materials and ensures adequate disinfection.

REFERENCES

1. Lattimer, J. K., Kenney, M., Rosenblatt, G., and Goldman, M.: Inadequate Sterilization of Cystoscopes, J. Urol. **76**:197-199, 1956.
2. Wechsler, H., Lattimer, J. K., Rosenblatt, G., and Goldman, M.: Studies on Sterilization of Cystoscopes, Am. Rev. Tuberc. **76**:909-911, 1957.

VETERANS ADMINISTRATION HOSPITAL
130 W. KINGSBRIDGE RD.
BRONX 68, N. Y.

INSTRUCTIONS TO DENTURE PATIENTS

WILLIAM G. MAISON, D.D.S.
San Francisco, Calif.

UPON THE INITIAL DELIVERY of the dentures, preparation of the patient to receive his dentures gracefully should be a part of prosthetic instruction. A printed message from the dentist will instill confidence in the patient and let him know that success depends also upon his cooperation. This message should be on an educational basis explaining in clear, concise language that which the patient may anticipate.

The professional customs followed by the medical profession regarding care and home treatment are delivered in printed forms in cases of postoperative expectations in tonsillectomies, prenatal and postnatal care, etc.

Printed information will acquaint the patient with the peculiarities of his newly acquired restorations and would unquestionably produce a better relationship between the dentist and the patient. These instructions will allay the unnecessary fears and anxieties of the patient and save the dentist many unnecessary interruptions and telephone calls.

However, each patient must be treated individually along with these routine instructions.

YOU AND YOUR DENTURES

Most individuals are in a quandary when their natural teeth cannot be retained and complete dentures are their only choice. Many thoughts flash through their minds. What will these dentures do to my appearance? Will my lips appear out of shape? Will I develop wrinkles? Will I look old? Will I ever again enjoy a good meal?

Fears and doubts of patients are among the most serious problems in dentistry. These motivations are upon their subconscious mind, and they do not know why they react with terror to a situation which must be met. Many denture patients undergo severe psychologic stress and strain. "Professional men try to understand the emotional elements involved in the disease process and try to take the patient himself into consideration."[1]

The happy denture patient prepares his mental condition for success in the use of the dentures. By trial and error and with patience and cooperation, he learns to conquer his problem the same as he learned to ride a bicycle, skate, or drive a car. Some people are more proficient and learn different accomplishments in life easier than others. However, with the dismissal of any negative attitude, we con-

Received for publication Oct. 1, 1958; revised by the author June 15, 1959.

quer denture problems as they present themselves. As President Roosevelt stated during World War II, "There is nothing to fear but fear itself."

The science and art of dentistry have developed by leaps and bounds. Improvements, scientific research, and experimentation are ever surging forward. The dentures worn by George Washington are a far cry from those worn today. "Dentistry's crowning achievement is the successful restoration of the lost dentition by mechanical means."[2]

APPEARANCE

Let's look into the mirror and observe my third set of teeth. I lost my old teeth because they were broken, unhealthy, probably out of line, discolored, or worn. Now as I look into the mirror at my new teeth, I see that they have translucency, reflect the light, have the proper color to blend with my eyes, hair, and general tone of my complexion, and are in harmony with the contour of my face. My lips show the correct amount of teeth, and the teeth are not unduly irregular. With the latest and exciting developments in color and form of denture bases and with the perfect reproductions of the color and vascular appearance of my own gums, I look better, feel better, and am not ashamed to smile. These dentures are indeed a reproduction of beauty.

Of course, the apprehensive and nervous denture patient has a strained facial expression because he has not been prepared psychologically for dentures. At first, your facial expression may seem altered slightly because of the sudden change. It takes time for the muscles and lips to relax and assume their natural position around your dentures. However, with the right spirit in mind, complete success will not be far away.

SPEAKING WITH DENTURES

At first, there is a feeling of a full mouth and a crowding of the tongue because the dentures have altered the shape of the mouth. You will be conscious of something in your mouth that was not there before, and you will have to learn to speak. However, as soon as the lips, tongue, and cheeks have become accustomed to the dentures and new muscle habits are formed, this difficulty is overcome easily.

A good way to learn to speak is by reading aloud before a mirror and carefully enunciating each syllable. You will recall that this same interference with speech was evident when you were without your own teeth. It is due to the presence of a foreign material in the mouth (the dentures) and with a little patience and practice it will disappear.

Most people find speech with new dentures almost automatic because of the high degree of adaptability and behavior of the tongue. However, the patient with impaired hearing sometimes has difficulty in proper pronunciation of words due to the difficulty of perception (lack of ear training) to compensate for the phonetic sound of his speech. Kessler[3] says, "The majority of denture wearers do not have any trouble with their speaking procedures. Of this enormous number of satisfied denture wearers, a certain percentage have dentures which are phonetically correct for them and the remaining percentage of the total have been able

to compensate with their tongues or lips for the phonetic shortcomings of their dentures. Of this second group of patients, the majority compensate almost automatically because of the amazingly high degree of adaptive behavior of the human tongue."

FULLNESS AND GAGGING

Upon receiving your denture, you will be most conscious of its bulk and have a feeling of unusual fullness. As a result, an extremely nervous individual may develop a slight nausea or gagging sensation. However, these complaints are mastered in a short time with a reasonable amount of courage and determination. The musculature, tongue, glands, throat, lips, and cheeks (which you may be biting) soon become accustomed and habituated to the dentures.

SALIVA

An abundance of saliva is a natural condition and is not objectionable because it aids in the lubrication, digestion, and swallowing of foods. You simply swallow more often, and in a few days, the salivary glands will adjust themselves to the presence of the dentures and resume normal function.

TENDERNESS

You must anticipate some tenderness and discomfort from your dentures during the first few weeks. The reason is that the mucous membranes of the mouth are sensitive tissues and must become toughened to withstand the pressures placed upon them by the dentures.

We have been wearing shoes the greater part of our lives and the tissues of our feet have been accustomed to shoes. However, most people experience a "breaking-in," toughening, or callousing of the tissues of their feet each time they purchase new shoes. Therefore, with the living, sensitive, vital tissues of the mouth we must expect to compromise and endure some of these annoying inconveniences.

Your new dentures will require some adjustments, and your dentist can detect and relieve the irritations. If adjustments are necessary, your dentures should not be removed from your mouth because the sensitive areas will heal, and the dentist will not be able to see the sore spots. The adjustments may be very minor in order to restore comfort and usefulness, but you should not attempt to adjust the dentures yourself.

Do not use the dentures too vigorously at first. Too much pressure will injure the tissues under them. One should not expect to eat anything and everything. Hard and chewy foods should be avoided to give the ridges time to become toughened to the pressures of mastication. It takes many weeks for these tissues to become hardened and accustomed to their new duties.

You will aid in the alleviation of tender spots by not clenching and biting upon your teeth when you are not eating. Your dentures are to be used only with functional pressures when you are eating. During the other periods of the day, they should be at rest and free from excessive pressure. The nervous or hyper-

sensitive person may form the bad habit of biting or chewing on his teeth and cause unbearable pain upon the tissue due to the constant irritation. This procedure would cause undue soreness and aching of your natural teeth.

The denture wearer must prevent food from passing under the denture and causing discomfort. Dentures settle into the everchanging tissues of the mouth and may cause tenderness at any time, even to the experienced denture wearer. Therefore, a dental checkup every six months is advisable so that you may obtain maximum efficiency, ease, and comfort from your dentures. All appliances need servicing, so why not your dentures?

Allergic reaction to the materials used in the dentures as a cause of irritation has not been substantiated. Your dentist will prescribe the proper mouth wash to fit your condition. He may also prescribe an analgesic ointment to be placed upon the dentures for the relief of discomfort during the initial period.

The use of tranquilizing drugs may be of assistance to allay the apprehension of adaptability to dentures. Hence, generalized anxiety and tension are reduced. This medication relaxes both mind and muscle and puts you at ease for better tolerance and cooperation. Do not be reluctant to accept the advice of your dentist.

SLEEPING WITH DENTURES

You will eventually become accustomed to your dentures, and they will feel as a part of you. In most instances, they should be worn throughout the night. This continual wearing of the dentures helps keep the face in its normal shape, prevents strain on the joints of the jaws, maintains conformation of the cheeks and lips, and maintains the tone of the muscles.

However, some patients have difficulty in wearing dentures at night because they interrupt their sleep. The nervous patient who continually grits and grinds his teeth will cause soreness and irritation of the supporting tissues and the dentures will become loose. You should secure the advice of your dentist regarding the wearing of your dentures while sleeping because the conditions in your mouth might be such that they should be left out.

EATING

The last but the most important function of our dentures to be achieved is that of chewing food. The maintenance of a long life and good general health is dependent upon sufficient mastication of food. Probably we have to wear dentures because we did not eat a well-balanced diet or chew our food properly with our defective natural teeth. We may have developed constipation or stomach ailments. It will take time to achieve success in this phase of denture experience. You must approach it with determination.

Learning to use your denture can be compared with learning to use an artificial limb. We must learn to make the denture function as we would learn to walk upon an artificial leg.

At first you should eat soft foods that require little chewing. You must learn to manipulate your dentures and swallow soft but not "chewy" foods. Little by little you can graduate into the more crisp foods. You must not be too ambitious.

Take small bites of food, chew each bite thoroughly, and avoid washing and swallowing with too much liquid. The longer you take for your meals, the quicker you will master your dentures. The old adage "practice makes perfect" fits well here.

Since eating is your most trying experience, be persistent and patient. You must gain skill in chewing with your dentures by controlling muscular action. Do not "show off" by tackling corn on the cob or biting into an apple until you have mastered your dentures. These are difficult feats and only lead to discouragement unless you know how to do them.

You do not receive the same efficiency or satisfaction in chewing from dentures that you did with healthy, natural teeth. This is truly dentistry's challenge—to replace the anatomy of man. It is surprising that we can accomplish this in part even with great skill and dexterity.

The manufacturers of artificial eyes have been most dexterious in their development of an eye that is hardly detectable from the natural eye. However, it is impossible to see through it, and there is also the discomfort of the "breaking-in" and fitting period. Therefore, with the restoration of teeth, if we obtain a small percentage of their natural function, we have attained the miraculous.

DENTURE HYGIENE

Dentures should be cleaned upon arising, after eating, and when retiring with a small, utility hand or nail brush with heavy bristles. The dentures should be scrubbed thoroughly with ordinary soap and cold water. Gritty or abrasive powders or paste should never be used as they remove the gloss and cause scratches which mar the surfaces and destroy the fit of the dentures.

The wash basin should be filled with water to prevent breakage should the dentures slip from the hand during cleansing. Since the denture may slip from the fingers, it should be held in the palm of the hand while clenching the hand against the side of the denture. A fine cleansing powder can be used occasionally to remove unsightly stains on the teeth. Periodic servicing of your dentures should be done by your dentist to maintain their well-groomed appearance.

If the dentures are left out of the mouth for any length of time, they should be placed in a saturated solution of salt and baking soda or a boric acid solution. This affords them safe and protective storage. The dentures should not be allowed to dry out as moisture is released and they may become warped.

NOSTRUMS

Powders, pastes, pads, plastic reliners, and "do-it-yourself" denture fitters should not be used without the consent of your dentist. Many of these "would-be" denture aids are harmful to the mouth. Your denture is a *precision*-constructed restoration made with the accuracy of a fine watch. It should be treated accordingly.

IMMEDIATE DENTURES

An immediate denture is one that is inserted immediately following the removal of the remaining natural teeth. Hence, the patient maintains the symmetry and

poise of the face, and there is no interruption with business and social contacts due to "toothless days." The facial expression and the muscle tone of the cheeks and lips are less liable to undergo changes than if there is an edentulous period. Normal speech is maintained and the difficulties of manipulation are more quickly overcome.

The immediate denture acts as a splint or bandage, reduces postoperative pain and bleeding, shields the tissues from injury and infection, and promotes healing. There is less discomfort than when dentures are placed in the mouth several months after the teeth have been removed. As the gums heal, the remaining ridges shrink because of the changes from natural teeth to an edentulous condition. However, in time, immediate dentures loosen. The rapidity of these changes varies in different individuals.

When the immediate denture has served its purpose, a second denture should be constructed. The immediate denture can be retained by the patient as a spare in case the second denture is lost or damaged. However, the final procedure can be altered by the dentist. The immediate denture may be relined or a second denture made, depending upon the dental and general health of the patient.

IMPLANT DENTURES

An implant denture is one for which a metallic framework is embedded under the soft tissues of the jaws against solid bone. Connective tissue fibers enmesh themselves around the metal framework, reattach to the bone, and bind the implant firmly to the jaw bone. Metal posts protrude through the gums and are used to support a removable partial denture.

Implant denture construction must still be approached with care and caution. "There is much basic research to be done in clinical, animal and histopathological study before many aspects of this work can be understood."[4] Denture implants *are not* intended to replace conventional dentures. However, progress is being made on this type of restoration.

REMOVABLE PARTIAL DENTURES

The removable partial denture, of which there are many types, designs, and shapes, fits around the remaining teeth and replaces the missing teeth. Removable partial dentures are restorations of precision and should be handled accordingly. Removable partial dentures maintain the form of the face in its normal position and prevent the natural teeth from drifting, tipping, elongating, and interfering with the biting pressure. An unbalanced biting pressure will cause the remaining natural teeth to do the work of a full complement of teeth. Eventually, they become sore, loose, and are lost due to the terrific overburden of chewing pressure placed upon them.

The removable partial denture is held in place by clasps or precision attachments. The remaining natural teeth receive some wear from the attachments. However, the wear is negligible in comparison to the benefits that are derived from these restorations.

Routine examination will prevent the loss of the remaining natural teeth and will prolong the usefulness of the replacement. Decay, undue stress, strain, or wear upon the teeth will be observed, and measures can be taken to preserve them.

The care for removable partial dentures is the same as that described for complete dentures.

CONCLUSION

Dr. W. W. Bauer, Director of Health Education of the American Medical Association, said, ". . . a good appearance may not be felt consciously, but it exercises a genuine influence on the personality and the attitude as one faces the day's problems and perplexities. Clothes may not make the man, or the woman, but good clothes, a good hairdo (or cut), a clear complexion and a SPARKLING SMILE are real and important factors in making that first impression a good one."[5]

REFERENCES

1. Watts, D.: Psychosomatic Dentistry, Internat. D. J. **8**:55-57, 1958.
2. Hart, F. L.: Full Denture Construction, J.A.D.A. **26**:455-461, 1939.
3. Kessler, H. E.: Phonetics in Denture Construction, J.A.D.A. **54**:347-351, 1957.
4. Cranin, A. N., and Cranin, S. L.: Utilization of the Partial Denture Implant in Complete Oral Rehabilitation, J.A.D.A. **56**:218-229, 1958.
5. Bauer, W. W.: Health for Today, San Francisco Examiner, Sept. 4, 1958.

Room 709, Phelan Bldg.
760 Market St.
San Francisco 2, Calif.

WHAT THE PATIENT SHOULD KNOW ABOUT COMPLETE DENTURES

JOSEPH GEORGE NAYLOR, D.D.S.
Howell, Mich.

PATIENTS WHO ARE about to lose their natural teeth are concerned with many details. Some of these are the general facts about dentures, extraction of the teeth, the length of time without teeth, mastication of food, appearance, speech, comfort, servicing of the dentures, and the maintenance of dentures. The patient is relieved usually of these questions by a pre-extraction examination and a prognosis by the dentist.

The physical condition of the patient, the mental attitude about wearing dentures, the confidence of the patient in the dentist, and a recognition of the factors involved in the construction of the dentures are the main points upon which the prognosis is made. The prognosis is a prediction of the success of the patient in wearing complete dentures.

A recognition of the factors involved in the construction of the dentures determines the fee. An agreement is made to construct, adjust, and service the dentures for a certain time, usually 60 days. The living tissues which support the dentures sometimes undergo various changes to disturb the fit of the dentures, and, because these changes are beyond the control of the dentist, the patient must assume this responsibility.

GENERAL FACTS ABOUT COMPLETE DENTURES

Complete denture construction deals with the scientific procedures necessary to replace missing teeth by artificial substitutes. The scientific procedures involve the maxillofacial structures. The maxillofacial structures are an arrangement of muscles, bones, and organ spaces, and consist of the tongue, the jaw bones, the teeth, the roof of the mouth, the lips, the facial muscles, the mouth cavity, and the air sinuses. This group of structures in combination with the central nervous system controls the functions of mastication, swallowing, breathing, and speech. The form of these structures is responsible for the appearance of the face. The normal function of these structures in conjunction with a proper diet is the most important single factor for maintaining the health of the entire body.

Complete dentures must be constructed in harmony with the maxillofacial structures. The dentist is a specialist who has the knowledge, skill, experience, and handicraft to restore mastication, correct facial disturbances, correct speech, prevent discomfort, and preserve the structures upon which the dentures rest. All objectives may be attained, but, because no two mouths are exactly alike and because

Received for publication Nov. 6, 1958.

some vary greatly from the ideal, it is sometimes necessary to sacrifice one objective to favor a more important one.

The most important objective is the restoration of mastication. Impaired mastication may cause poor digestion, with serious disturbance of normal body functions and general ill-health. All eating movements require that the teeth come into proper contact and that they are arranged in harmony with the jaw movements of each patient. This is accomplished by observing certain scientific laws and by recording the jaw movements of the patient and transferring them to an instrument called an articulator.

Scientific planning and designing result in construction of satisfactory dentures. The dentures are adjusted for a certain period, usually 60 days, these services terminating the original agreement. All first dentures require relining in time, and as this is not a part of the original agreement, a fee is required.

Satisfactory dentures is a term relating to the efficiency of the dentures in proportion to the conditions of the denture-supporting structures. Satisfactory dentures for patients with normal denture-supporting structures are more efficient than satisfactory dentures for patients having unnatural denture-supporting tissues.

Misconceptions regarding the fee for complete dentures are common. The fee is a charge for professional services which consist of knowledge, experience, skill, handicraft, and the necessary time to carry out the treatment of each patient.

Another fallacy is that dentures are permanent. Tissue changes occur all of the time, and it is necessary that dentures be adjusted periodically. The changes vary to such a degree in different individuals and in different parts of the same mouth that treatment cannot be predetermined but must be remedied when the changes occur.

EXTRACTION OF THE TEETH

A complete series of roentgenograms and a case history should be obtained if the most efficient service is to be rendered. An appointment schedule is made to extract the remaining teeth. The schedule depends upon the physical condition of the patient as well as the general condition of the mouth and teeth.

Unless the age or the general condition of the patient forbids, the remaining posterior teeth of the lower jaw may be extracted at one time, followed by the remaining posterior teeth of the upper jaw at the next appointment. The posterior ridges of both jaws are allowed to heal until they are relatively smooth. The upper and lower front teeth are retained to preserve the positions of the jaws and the normal appearance of the face. When the condition of the posterior ridges is satisfactory, the upper and lower front teeth are usually extracted at one time. This plan is modified to suit various conditions.

A patient having all or nearly all natural teeth at the time of the pre-extraction examination will benefit by the proper timing of the extractions and the insertion of the dentures. Immediate denture procedures should begin just as soon as the posterior ridges are in a satisfactory condition for dentures, and this is the proper time to extract the anterior teeth for near-immediate dentures. Any delay will cause an unnecessarily prolonged impact on the anterior teeth, resulting

in destructive changes of the upper and lower ridges. Continued disuse of the posterior ridges after they are in a satisfactory condition to support dentures also causes destructive changes, while the pressure of dentures stimulates the tissues.

Denture patients usually reduce the quantity of protein-rich foods during the healing period and during the period of learning to eat. The patient's diet should be supplemented with a balanced combination of water-soluble vitamins and bone meal to maintain the general health.

THE LENGTH OF TIME WITHOUT TEETH

The length of time the patient is without teeth depends upon the type of dentures decided upon. Formerly, most dentures were made after several months of waiting for the gums to heal and for the bony ridges to shrink. After going without teeth for 2 or 3 months, disuse shrinkage of the bony ridges usually begins and continues indefinitely after the dentures are worn. Thus, the dentures may need to be relined often. The tongue, a powerful muscular organ, normally rests on the back surfaces of the lower front teeth, but when the teeth are missing for several months, the tongue enlarges to fill the space formerly occupied by the teeth. The enlarged tongue dislodges the lower denture until the tongue returns to its normal size which causes some patients difficulty in wearing the lower dentures. This long period of waiting also causes difficulty in reactivating normal muscular actions in eating. These disadvantages are eliminated by immediate dentures or near-immediate dentures.

Immediate dentures are inserted immediately following the extraction of the remaining teeth and are suitable for most persons except diabetic and tubercular patients, chronic invalids, or those in ill-health who require extensive surgery. Immediate dentures have many advantages since the dentures act to bandage the open gums from injury and promote a more rapid healing with less discomfort. The muscles of speech and expression are disturbed only moderately, and the patient can go about his business or social life as usual. Because the dentures are finished while the patient has his natural anterior teeth, there is no chance to see and approve the appearance of the dentures before they are finished, and the patient must rely on the judgment of the dentist. Immediate dentures demand more time and adjustments than near-immediate dentures and require a higher fee.

Near-immediate dentures usually are made 1 or 2 weeks after the remaining anterior teeth are extracted, and after all swelling is reduced. Near-immediate dentures are as satisfactory as immediate dentures except there is a short period in which the patient is without teeth. Before the dentures are completed, they are tried in the mouth and checked for appearance. The patient has a choice to approve or request changes.

MASTICATION

Restoration of mastication is the first and most important objective of denture construction for most patients. Mastication prepares the food for swallowing and is the first step toward digestion. The structures of mastication are important to the maintenance of health. They consist of the upper and lower jaws, the muscles that

control the lower jaw, and the muscles that control the food during mastication. The patient must have some knowledge of these structures to use complete dentures efficiently and to understand why some difficulties occur.

The upper jaw has no movement and is the base against which the force of mastication is applied. The lower jaw, in combination with the muscles which control it, is the main agent in mastication. When the teeth of the lower jaw are brought with force into proper contact with the upper teeth, they act as a mill, crushing and grinding the food. The muscles which control the position of the food during mastication consist of those in the lips, the tongue, and the cheeks. The lips and the cheek muscles prevent the food from moving outward and force it back into the path of the teeth. The tongue moves the food out into the path of the teeth. Because of the wide range of movements of the lower jaw and because the force of mastication is exerted by it, the lower denture presents the greatest problem in learning to use complete dentures.

Complicated jaw relation records of the patient must be made and are used to mount the casts of the patient's jaws on an articulator. Artifical teeth are arranged according to scientific and mechanical principles which allow them to meet properly during the movements of the lower jaw in mastication. The first of these movements is a hingelike action used to open the mouth for the insertion of food and to close the mouth to bring the opposing teeth into contact. The upper edges of the lower front teeth are behind the upper front teeth. Some foods can be crushed by this action but cannot be reduced to a fine condition. The second movement is a shearing action of the opposing teeth used to bite off a portion of food such as a sandwich. The lower jaw is depressed and as the food is inserted, the lower jaw is moved forward and upward in a closing action. The opposing front teeth meet end to end and pierce the food; then the lower jaw is returned to its normal position as the upper edges of the lower front teeth move upward against the backs of the upper front teeth to complete the shearing action. When biting food, pressure on the food applied toward the dentures assists in keeping the dentures in place, while pulling on the food tends to dislodge them. The third or lateral movement of the lower jaw is the most important and the most efficient means of reducing food to the fine condition necessary for proper digestion. The lower jaw can be moved in various right and left lateral movements, as the sliding surfaces of the opposing teeth grind the food finely.

Learning to master the movements of the mandible is a gradual process. The length of time depends upon the ability, the patience, the perseverance, and the determination of the patient. Because age, general health, jaw relations, muscle formation, and tone of the tissue directly influence the result, some patients learn slowly while others have very little difficulty. Only soft foods should be eaten until the first adjustment is made, after which the patient can gradually progress to more difficult foods. The beginner should chew small portions of food slowly on both sides of the mouth. Mastication of food with natural teeth consists of shifting the food back and forth from one side to the other and chewing on one side at a time. Because artificial teeth are entirely different from natural teeth, these habits must be discontinued. The food must be divided in the mouth so that, at all times while chewing, there is food on both sides to prevent the dentures

from becoming unbalanced. Some patients expect too much while others realize that there are certain shortcomings of complete dentures. Eating habits must be changed to meet the new situation.

APPEARANCE (ESTHETICS)

Correction of facial dimensions due to loss of the teeth, disease, or age is the second objective of complete denture construction. The expression and the smile identify the individual personality of a human being. The personality center is in the location of the mouth, and this part of the face is supported by the jaws, the soft tissues, the lips, and the teeth. Changes of the face due to the loss of the teeth and the bony structure of the jaws destroy the individual personality factor. Pre-extraction records are valuable aids in restoring the natural appearance.

Denture esthetics consists of the major qualities of beauty, harmony, naturalness, and individuality. The dentist must analyze the facial beauty factors of the patient and create the qualities best suited for that patient by artistic ability and creative skills. The teeth should be beautiful, pleasing, natural, individual, and blend with the mouth and face. The jaw relation records establish the correct distance between the upper and lower jaws with the lower jaw in its proper position. Artificial teeth of the same size and form as the natural teeth arranged in the proper space between the jaws allow the jaw to assume natural positions in expressions of the face while speaking, laughing, or in expressing various emotions.

At the try-in stage, the artificial teeth are set in wax trial bases and are checked for appearance. Corrections can be made at this time, and it is absolutely necessary that *any objections of the patient must be made at the try-in appointment.* The finished dentures usually alter the appearance slightly until the necessary adjustments are made. First dentures cause a slight fullness of the lips because of the denture material covering the bony ridges. However, when the dentures are relined after the initial shrinkage, the denture material replaces only the shrinkage and the lips return to normal.

SPEECH

Correction of speech defects due to the loss of the natural teeth is the third objective of complete dentures. The speech habit is a fixed pattern of personal identity. The objective is to prevent the speech from being altered even slightly.

Speech is produced by the same structures used in mastication and is dependent upon a stream of air exhaled from the lungs. The basic sounds are produced by the resistance of the vocal folds of the larynx to the exhaled stream of air. The sounds are modified by the pharynx, the mouth cavity, and the air sinuses which are responsible for the vibrating quality of speech. The sounds are modified further into speech within the mouth cavity by the lips, the teeth, the tongue, and the roof of the mouth. The tongue performs the actual mechanics of clear speech by contacting the teeth or the ridge behind the upper teeth. Different sounds are produced by different contact positions of the tongue, lips, palate, and teeth.

The objective of speech is obtained by arranging the artificial teeth in the same positions as the natural teeth, by making the denture material have the right

thickness, by shaping the base material of the upper denture behind the teeth to the exact shape of the natural palate, and by restoring the normal distance between the upper and lower jaws.

COMFORT

Prevention of discomfort or undue destructive changes of the tissues supporting the dentures is the fourth objective of complete denture construction. The dentist plans and designs each denture in a manner similar to the work of an architect. He constructs the dentures according to engineering principles while using his knowledge of esthetics, sculpturing, and anatomy.

Discomfort during the adjustment period varies considerably depending on age, general health, condition of the mouth, state of mind, and cooperation of the patient with the dentist. The younger the patient, the sooner the dentures become comfortable. However, all ages adjust reasonably well except very old persons. The aging process of the tissues in the mouth causes a tenderness which can be irritated severely by the stress of even well-fitting dentures.

The aging process may also result in a decrease of saliva causing a dry mouth, a burning sensation of the mouth tissues, and a peculiar taste. Saliva plays a part in the retention of dentures. A normal flow of thin saliva assists in holding the denture in place, but a heavy ropy saliva displaces tissue and causes the dentures to become loose. Ropy saliva under dentures produces a squashing sound when eating. A mouthwash of normal salt solution used before inserting the dentures usually eliminates this nuisance. A retarded flow of saliva causes the tissues of the mouth to dry and be in a constant state of mild irritation. The dentures must be moistened frequently to prevent looseness.

Tissues of healthy patients react favorably to the change to dentures, and the dentures quickly become comfortable. Patients with impaired physical conditions require varying lengths of time before the dentures become comfortable. The length of time and the degree of comfort depend upon the condition of the patient.

The condition of the mouth will influence the comfort of the dentures. Patients who have gone for long periods of time with most of their posterior teeth missing suffer a breakdown of the front part of the bone of the upper jaw. Those who have had individual teeth extracted at different times may have large bony prominences or deep undercuts. These patients experience more difficulty than those who have had all or most of their natural teeth extracted according to a definite plan.

A cooperative tolerant state of mind of the patient is essential to the eventual comfort of the dentures. There will be some initial discomfort because the dentures are supported by living tissues, but the patient must learn to adjust to dentures and to follow the instructions of the dentist with confidence. The patient must assume the responsibility to learn to use the dentures, to accept their disadvantages, and to seek the help of the dentist in overcoming the difficulties encountered.

ADJUSTING TO THE DENTURES

The patient's first impression when complete dentures are inserted is a feeling of fullness in the mouth. This is natural and disappears as soon as the tongue, the

lips, and the cheek muscles return to normal. An initial feeling of looseness disappears when the mouth tissues become adapted to the dentures. An excessive flow of saliva is due to the stimulation of the salivary glands which return to normal in a short time. A gagging sensation is usually due to a nervous reaction but soon passes as the tissues become adapted and the dentures are adjusted. Hard candy held in the mouth helps normal swallowing and prevents gagging until the dentures are relieved. A strained appearance about the mouth gradually returns to normal when the muscle tone is regained because of the support of the dentures. Slight defects in speech usually disappear when the tongue becomes accustomed to the dentures.

The first twenty-four hours are the most difficult time for the patient. During this time the dentures should not be removed from the mouth, nothing but soft food should be eaten, and the patient should refrain from clenching the teeth. Clenching the teeth damages the ridges, and for this reason a space has been provided between the upper and lower teeth so that the teeth will not touch when the jaw is at rest. The only time it is necessary to exert pressure on the teeth is while eating. During the first day, the initial settling of the dentures may cause irritation or soreness of the supporting tissues and the dentures may be displaced by overextended borders.

No two patients have the same reaction to the wearing of dentures. Some patients have little discomfort and only slight adjustments are necessary, while others may experience some pain. Regardless of discomfort, the dentures should not be removed until the following day appointment at which time the dentures and the mouth are examined and the proper treatment is given. The amount of adjustment depends upon the extent and the degree of the sore spots. The sore spots fade if the dentures are left out before an adjustment and this prolongs the adjustment period. Sore spots due to overextended denture borders become comfortable immediately after being adjusted, but if the dentures are removed the tissue may swell under the dentures, making the proper adjustments difficult.

Usually after the first adjustment the feeling of fullness disappears, the dentures feel tighter, the appearance improves, the speech becomes clearer, and the dentures are more comfortable. For the next few days, soft foods can be changed gradually to more solid foods. As the tissues toughen, the patient becomes more proficient in the use of the dentures. Minor adjustments are necessary from time to time, and appointments should be made for this purpose.

First dentures should be kept in the mouth at night because the time necessary to become adjusted to wearing dentures is shortened and the tissues become better adapted. After the patient becomes adjusted to wearing dentures, the tissues supporting the dentures benefit by leaving the dentures out for a time each twenty-four hours, either day or night.

MAINTENANCE

All living tissues are changing continually, and it is only natural that the tissues that support the dentures also change. Properly constructed dentures have a stimulating effect upon these tissues and slow this destructive action. While tis-

sue change is a gradual process, it is more rapid when teeth are extracted and first dentures are worn, regardless of whether the dentures are immediate, near-immediate, or dentures made after a long period of waiting. All first dentures need to be relined when the amount of shrinkage of the ridges cannot be compensated for by adjustments and the dentures become loose or ill fitting, with a loss of efficiency in eating. When first dentures are made, special care is taken to prevent undue shrinkage and to preserve the structures which support the dentures until the dentures require relining. Since the lower jaw is the active part of the masticating machine, the shrinkage of these tissues is more rapid and the lower denture usually requires relining first. The proper maintenance of the dentures is a responsibility of the patient, and as this is not a part of the original agreement, a fee is necessary.

Failure to reline first dentures at the proper time may cause various serious destructive processes of the structures of mastication. For example, (1) when ill-fitting dentures cause excess pressure on the front teeth, the bony ridge under the teeth may be destroyed, leaving soft, tender, flabby tissue which will not support dentures properly or comfortably, (2) when ill-fitting dentures are worn on poor ridges, the destruction of the ridges may be so severe that the success of a second set of dentures is questionable, (3) when the shrinkage is severe over a long period of time, the lower jaw moves forward in its sockets and it is necessary sometimes to construct a second or a third set of dentures to return the structures of mastication to normal, and (4) when severe shrinkage causes the lower jaw to move out of its normal centric position, the lower denture may have to be remade or a new set of dentures may be necessary. When the dentures are relined at the proper time, the shrinkage of the tissues is so gradual that the dentures are efficient for approximately five years.

Periodic examination and maintenance of dentures to preserve the balanced occlusion are just as important as the periodic examination and maintenance of natural teeth. An examination twice a year helps to keep the dentures in good order and preserve the structures of mastication. At these examinations any necessary adjustments can be made, the dentures can be polished, and deposits of calculus can be removed.

NUTRITION

Good nutrition is essential to the success of dentures and to the maintenance of the tissues supporting them. With an adequate diet consisting of the necessary proteins, vitamins, and minerals, the structures of the mouth are more comfortable under dentures and the shrinkage is less.

Proteins are essential to the fluids and tissues of all living things. Proteins repair worn-out tissue and build new tissue. The principal protein foods are meats, eggs, milk, and cheese. Protein deficiency is the most frequent type of malnutrition, often causing many diseases, a general weakness, and a softening of the bones of the jaws.

The vitamins function to maintain health and vigor and contribute to the nervous stability of the patient. The essential vitamins are found in milk, butter, eggs, fruits, vegetables, and whole-grain cereals.

The essential minerals, with the exception of calcium, are usually present in the average diet. Foods rich in mineral elements are green vegetables, fruits, milk, eggs, lean meats, liver, and whole wheat. Calcium is necessary to maintain strong bone in the ridges that support the dentures, and a deficiency of calcium may cause these bones to become soft, resulting in severe tissue shrinkage under the dentures.

Some patients lose their teeth because of a high carbohydrate diet. If this diet is continued after they become denture wearers, the gums are tender and the tissue shrinkage is greater than normal. Carbohydrates produce heat and quick energy for the body. Fats also yield heat and energy, but the food value is two and one-half times greater than carbohydrates and is essential to form the structure of body tissues. A well-balanced diet containing a high percentage of animal fats and proteins and a low percentage of carbohydrates is necessary to keep the supporting tissues of the denture in good condition.

CARE OF THE DENTURES

Only clean dentures are comfortable dentures. Dentures should be removed and held under running cold water after every meal, and the mouth should be cleaned of food particles by rinsing it with water. Hot water should never be used because it may warp the dentures. A special denture brush and a denture cleanser should be used at least once a day. Bicarbonate of soda or ordinary soap are effective cleansers. Regular tooth paste or abrasives should never be used. Water should be kept in the wash bowl while cleaning dentures to prevent them from being broken in case they are dropped. When dentures are left out of the mouth, they should always be kept in water to prevent them from warping. A little borax in the water will help to remove stains and tartar.

112 E. Grand River Ave.
Howell, Mich.

THE HISTORY OF PROSTHETIC DENTISTRY

WALLACE W. JOHNSON, B.S., D.D.S., M.S.*
The State University of Iowa, College of Dentistry, Iowa City, Iowa

THE TEETH ADD SIGNIFICANTLY to the beauty of the countenance and are indispensable to a correct enunciation of speech sounds. It has been a practice to replace natural teeth with artificial ones when they are lost by accident or disease. Therefore, this article attempts to relate the most important incidents pertaining to the growth of the science of prosthodontics.

Probably the earliest records of any form of dental treatment date back to the fourth or fifth century B.C. The dental art of this era followed very closely the course of medicine, as it was an active part of medical practice. Egypt was the medical center of the ancient world, and the earliest records of dentistry come from writings found during archaeologic expeditions to this area. The records from Egypt seem to be contradictory, however, to the clear picture of early dental practice in Phoenicia, Greece, Rome, and Tuscany.

The first dental prosthesis is believed to have been constructed in Egypt about 2500 B.C. The specimen was found by Herman Junker[1] in 1927, in an Egyptian tomb of El Gizeh. The restoration consisted of a left third molar with resorbed roots that was linked to a left second molar by a gold wire woven around the gingival margins. Authors[1] of the sixteenth and seventeenth centuries wrote about artificial teeth made of ivory, gold, brass, and wood found in the mouth of mummies. This gives sufficient evidence that the simplest form of retentive prosthesis was being used in the treatment of the periodontal conditions then existing.

Writings in the Talmud, a book of rabbinical laws of the Hebrews from the second and fourth and sixth century in the Christian era, gave definite proof of dental prosthesis. It made mention of gold teeth, silver teeth, and gold crowns, and stated when forms of fixed partial dentures could be worn in public and displayed by the Hebrew women.

The dental arts of the early Phoenicians are best authenticated by the discovery of Drs. Renan and Gaillardt (1823-1892) in the Necropolis of Sidon. Dr. Gaillardt wrote, "A superior jaw of a woman showing two canines and the four incisors united by a gold wire . . . Two of these incisors seemed to have belonged to another person and to have been inserted there in order to replace those which were missing."[1,2] This specimen was important because it represented an example of the first step in actual dental prosthesis.

Specimens of prosthetic dentistry are found from the early Greeks, Etruscans, and Romans. The archaeologic findings of the Etruscans' dentistry seemed to be

Received for publication Oct. 31, 1958.
*Instructor, Department of Operative Dentistry.

the richest collection of ancient dental prosthesis of antiquity. Fixed partial dentures, made of soft or rolled gold, were used in Etruria as early as 700 B.C., and possibly earlier. Early dental prosthesis went through evolutionary steps. The order of development of restorations appears to be as follows: (1) Loose teeth were ligated by means of gold or silver wire. (2) Grass fiber, gold, or silver wire was passed through holes drilled in natural or animal teeth, and they were ligated to the teeth in the mouth. (3) Detached natural teeth were replaced, or teeth were replaced from another mouth. (4) Fixed partial dentures were made of soft gold, and appliances of gold wire or ribbon were used to support loose teeth. (5) Gold fixed partial dentures were constructed with teeth secured to the framework by rivets. (6) Fixed partial dentures that contained teeth incorporated by means of solder were constructed. (7) Fixed partial dentures that contained gold shell crowns were soldered to supporting loops of gold ribbon. This is the earliest known use of the gold crowns (Roman, 1st Century, B.C.). (8) Crowns were attached to abutment teeth by means of a supporting wire.

FOUNDERS OF MODERN DENTISTRY

Very little progress in prosthetic dentistry was recorded until the eighteenth century and the time of Pierre Fauchard, "the founder of modern dentistry" and "the father of modern dental prosthesis." Fauchard's work, *Le Chirurgien Dentiste,* written in 1723,[1,2] and revised in 1746 and 1786, suggests that he made many improvements in the field of dental prosthesis. Without doubt, he was active in the field of fixed partial prosthesis. His restorations ranged from one tooth replacements to nearly complete mouth restorations. He was the first to use what he called "tenons," which were, in reality, dowels or pivots screwed into the roots of teeth to retain fixed partial dentures. The credit for the idea of mineral teeth also goes to Fauchard, even though his work with them did not seem to be too successful. However, his greatest contribution was his influence in making dentistry a profession of high standards, and because of his work and influence, France became the leading country in dental progress and kept this title until America took it over some years later.

In 1746, Claude Mouton published the first book written exclusively on prosthetic dentistry.[2] The retention of removable partial dentures by spring clasps made of round gold wire and the use of the gold shell crown are described for the first time in it.

Etienne Bourdet ranked in importance with Fauchard in influencing the field of dental advancement. He published literature in two volumes which showed definite prosthetic advancements.

Prosthetic dentistry had its greatest forward movement during the eighteenth century because of the influence of these great men. The dentist of this era found it necessary to utilize that which nature provided in the way of artificial substitutes. The materials considered proper for artificial teeth were: (1) human teeth, (2) animal teeth cut to size and shape, (3) ivory, (4) natural teeth transplanted from one person to another, and (5) mineral (porcelain) teeth.

SOURCE OF TEETH

Human teeth were both scarce and costly and were not always obtainable. The source of teeth was from destitute people who could make money by selling their teeth, from the dead through the channels of the grave digger or robber, or from battle fields where soldiers had fallen. The crowns of the teeth were used, and they were utilized (1) by pivoting, (2) by ligatures, (3) by springs, and (4) on bases.

Animal teeth were not satisfactory because of their size, large pulps, and the work required to cut them to shape. They were most vulnerable to "corrosive agents" in the saliva.

Ivory, especially hippopotamus ivory, was used more than any of the dental substitutes. Pivoting was the preferred method of attachment of the teeth for both partial and complete dentures. Elephant ivory and bone was used in cheaper prosthetic restorations, but not satisfactorily. The pores in the ivory and bone caused these materials to stain easily.

In 1774, Duchâteau, an apothecary who was dissatified with his stained ivory dentures, began experimenting with minerals. With the help of porcelain manufacturers, he succeeded in making a set of dentures. However, in 1787, Dubois de Chemánt learned of Duchâteau's secrets and, being a dentist, made dentures for some of his patients from these materials. He is given credit for being the first dentist to successfully insert mineral teeth in the human mouth. However, the mineral paste or porcelain dentures were made in one piece, and most resulted in failure. The idea of making single mineral teeth, somewhat similar to those now in use, and attaching them one by one to a metallic base is that of Geuseppangelo Fonzi. His mineral teeth contained small platinum hooks which were inserted into the teeth before baking. These hooks were soldered to a metal base.

EARLY AMERICAN PROSTHODONTICS

The construction of dentures did not change much in early America because all techniques were brought over from Europe. However, early America did have many distinguished dentists. Men like John Baker, Robert Wooffendale, Isaac Greenwood, James Gardette, Josiah Flagg, Paul Revere, John Greenwood, and others dominated the dental scene. Robert Wooffendale constructed completed dentures for William Walton of New York in 1776, and is credited with being the first to construct complete dentures in this country. James Gardette was the first dentist in America to use clasps to retain dentures. John Greenwood is given the credit of having been the first dentist to make gold bases and, while in this country, he carved teeth from hippopotamus tusks for complete dentures for George Washington. He used spiral springs for the first time in America instead of the flat springs which were in general use.

PORCELAIN TEETH

Porcelain teeth were introduced to this country by Dr. A. A. Plantou in 1817, from France. They were called "Slit Beans." However, not until 1825, when Samuel W. Stockton began the manufacture of porcelain teeth, was there any im-

provement in artificial teeth. The greatest improvements were made by S. S. White when he began to manufacture teeth in 1844. In the years that followed many new companies manufactured porcelain teeth. Each was trying to outdo the other in creating a porcelain that would match the natural tooth in shades and translucency. The Dentists' Supply Company was formed during this era and has made one of the latest improvements in porcelain teeth. The vacuum-firing process has created a porcelain tooth that is strong and is similar to the natural tooth in both translucency and shade.

DENTURE BASE MATERIALS

All through the history of the making of dentures, we find a constant struggle of the dentist to find a suitable denture base. Wood, ivory, baked porcelain, gold, silver, cheoplastic metal, and celluloid were used, but a good fitting base was difficult to obtain from all of these. Of the metals, gold and silver were the best, but their cost was too great for the average patient.

In 1839, Charles Goodyear discovered a method of producing rubber, and in 1851, Nelson Goodyear invented a process for making hard rubber or vulcanite. In 1855, Charles Goodyear patented a process for making denture bases of vulcanite. The Goodyear Company then licensed dentists, for a fee, to use this method in their practices. The patents eventually became the property of Josiah Bacon. He was determined to enforce his patent rights and make a fortune from dentists. His ruthless methods cultivated a hate for him, not only in the dental profession but in the general public as well. Eventually, he was shot and killed by a dentist whom he was prosecuting in San Francisco. S. S. White took up the cause for the dental profession and spent much time and money in a struggle against this company that lasted for seven years. He won two cases but the mental strain of this struggle added to the cares of his own business cost S. S. White his health, and he died in 1879. Guerini[2] paid the following tribute to S. S. White: "Samuel S. White undoubtedly stands forth as one of the most noble and grandest figures in the history of Dentistry, and his name will ever be recorded with honor and veneration by dentists of all ages."

Vulcanite was almost the answer to the dentists' problem in the construction of dentures. Despite its displeasing appearance, vulcanite denture bases fitted the ridges of the patient more exactly so that the dentures could be worn with comfort. Vulcanite also brought good dentures within the price range of ordinary patients. Vulcanite stood the test of time, and it was used almost exclusively for more than seventy-five years.

In 1937, methyl methacrylate was found to be useful as a denture base.[3] In the beginning, methods of storing, packing, and curing proved to be problems. It was the most esthetic material for denture bases at the time. Much research went into this material; the result being that it is an economical, storable, and easily manipulated material for denture bases. Nylon threads have been added to break up the solid pink color and to resemble more closely the natural oral mucous membranes. Also, with the new methods of packing, the final result is a denture that is strong but thin and light, not bulky, and pleasingly esthetic. In the entire history of dentistry the dental cripple has never had as good an outlook as at present.

IMPRESSIONS

There was little to be found concerning the making of impressions in the early history of dentistry. Combinations of wax were used as the main impression material and plaster and other materials were used later.

ARTICULATORS

Articulators play an important part in the construction of good dentures. The positions and movements of the jaws in relation to the temporomandibular joints may be transferred quite accurately to these instruments. The first articulator was invented by J. B. Gariot in 1805. In 1840, Daniel T. Evans of Philadelphia patented the first anatomic articulator, but the first satisfactory instrument of this kind was the invention of Bonwill in 1848. Innumerable kinds of articulators have been devised since that time.

PRESENT PROBLEMS

Although many problems concerning dental prosthesis have been solved, many problems still exist. Retention of dentures has always been a great challenge. We depend on three factors to retain dentures: (1) adhesion, (2) atmospheric pressure, and (3) muscle coordination. Only in the rare instance of a malformation of the dental organ is the use of springs indicated. To obtain the greatest amount of adhesion and to make the greatest use of atmospheric pressure, the dentist must place emphasis on the impressions that are made for dentures. Accurate jaw relationship records are essential to make the dentures a better functional part of the person for whom they are intended. Through the years, dental history has shown a slow change from mechanical aspects to functional concerns for dentures.

SUMMARY

Progress has been made toward rehabilitating dental cripples. We pride ourselves on our dexterity and successful manipulation of our restorations. However, do we really evidence a skill more remarkable than the Etruscans, Phoenicians, Egyptians, and others when they, thousands of years ago, demonstrated with their crude instruments their wonderful attainments in dentistry? As J. H. Bass[4] wrote: "Millions and millions have perished without contributing to the progress of science; they have no history. Thousands have promoted at least the foundation of future knowledge; history records their names, for they labored. They summed up the past and discovered new and great truths, the intellectual products of many bygone factors of knowledge; they led humanity onward, and thus formed the landmarks of its history."

REFERENCES

1. Weinberger, B. W.: An Introduction to the History of Dentistry, St. Louis, 1948, The C. V. Mosby Co.
2. Guerini, V.: A History of Dentistry, Philadelphia and New York, 1909, Lea & Febiger.
3. Tylman, S. D., and Peyton, F. A.: Acrylics and Other Synthetic Resins Used in Dentistry, Philadelphia, 1946, J. B. Lippincott Co.
4. Anderson, G. M.: Practical Orthodontics, ed. 8, St. Louis, 1955, The C. V. Mosby Co.

5. Weinberger, B. W.: An Introduction to the History of Dentistry, vol. 2, St. Louis, 1948, The C. V. Mosby Co.
6. Bremner, M. D. K.: The Story of Dentistry, Brooklyn, 1939, Dental Items of Interest Publishing Co.
7. Taylor, J. A.: History of Dentistry, Philadelphia and New York, 1922, Lea & Febiger.
8. Tylman, S. D.: Theory and Practice of Crown and Bridge Prosthesis, ed. 3, St. Louis, 1954, The C. V. Mosby Co.
9. Lufkin, A. W.: A History of Dentistry, ed. 2, Philadelphia, 1948, Lea & Febiger.

State University of Iowa
College of Dentistry
Iowa City, Iowa

FIXED PARTIAL DENTURES

PORCELAIN FUSED TO IRIDIO-PLATINUM CROWNS

ARTHUR S. FREESE, D.D.S.
New York, N. Y.

ESTHETICS IS THE MAIN ADVANTAGE of the porcelain jacket crown. However, the porcelain jacket crown has definite limitations which are most apparent in occlusal reconstructions necessitating splints and fixed partial dentures. The porcelain fused to iridio-platinum crowns eliminates the deficiencies of porcelain jacket crowns in this work. This combination of materials makes possible the esthetic effect of porcelain together with the superior fit of a metal casting. The restoration has strength and resistance to breakage that is far superior to that of the porcelain jacket crown, and its esthetic effect is much better. However, it is not as stronge as the acrylic resin veneer crown.

IRIDIO-PLATINUM CASTINGS

The iridio-platinum casting is fabricated similarly to a full-cast crown. The prepared tooth is covered completely so that there is no danger of decay from seepage through a crack or check in the porcelain. As a result of this technique, the restoration could continue to be usable so long as enough porcelain remains to maintain the esthetics and the proper contacts with the adjoining and opposing teeth.

The iridio-platinum castings themselves are used as transfer copings when individual restorations are constructed. Only a band impression is needed. The castings are fabricated with buttons on the labial and buccal surfaces so that they may be removed easily with a crown remover (Fig. 1.)

Nonprecious metal transfer copings are necessary when teeth are splinted or used as abutments for fixed partial dentures. The iridio-platinum castings must have the proper proximal contours for soldering. The transfer copings are fabricated with buccal and lingual windows at the occlusal surface so that their seating can be checked accurately. They also have buccal and lingual buttons to facilitate their removal. Plaster impressions are made with the castings in position, casts are poured, and the iridio-platinum thimbles are fabricated on these casts.

Presented as a projected clinic at the Greater New York Dental Meeting, Dec. 9, 1957.
Received for publication Sept. 17, 1958.

RECORDS AND IMPRESSIONS

The iridio-platinum castings are seated in the mouth, and jaw relation records are made. Wax interocclusal records are unreliable. Therefore, a self-curing resin which can be inserted without pressure and which will set quickly to a rigid form is used (Fig. 2). The opposing casts can be seated accurately in this record.

The resin is painted over the occlusal surfaces of the lower castings and is extended down toward the gingival surface to grip the casting firmly. The interocclusal centric relation record is made at the correct vertical dimension by extending the acrylic resin over the upper castings without locking them in the material. Enough teeth are included in the record to assure an accurate seating of the casts. It is impossible to distort this record, and there is no danger of distortion by temperature changes.

Complete plaster impressions are made with acrylic resin registrations in position on the lower iridio-platinum castings. The casts poured in these impressions are mounted on a Hanau articulator by means of a face-bow. The condylar and incisal guidances are adjusted, and with these records it is possible to construct porcelain-platinum-iridium crowns and fixed partial dentures which are almost perfectly balanced. Minor adjustments are necessary in the mouth because no articulator duplicates exactly the movements of the mandible.

PONTICS

The iridio-platinum pontics are fabricated so that there is adequate thickness of porcelain on all surfaces. These castings do not contact the ridge, so that highly glazed porcelain is against the tissues. This provides the ideal material for maintaining the health of the soft tissues of the ridge.

A layer of opaque porcelain is baked directly to the iridio-platinum castings to hide the color of the metal. The crowns, splints, or fixed partial dentures should be tried in the patient's mouth after the biscuit bake and before the final glazing.

At times, it is necessary to use a cantilevered pontic. Porcelain fused to iridio-platinum backings should not be used for this purpose because too often the porcelain on the pontic fractures. A metal occlusal surface is always the safest surface for this type of pontic.

An advantage of porcelain-platinum-iridium crowns is that material may be added easily to any part of the crown in order to obtain balancing contacts or for esthetics. Wax is added and the porcelain is built to the contours established by the wax. No serious problem exists if the porcelain is ground so that the opaque layer shows through because porcelain bonded to iridio-platinum is extremely strong even when thin.

ESTHETICS

The most creative and esthetically satisfying procedure in dentistry is the production of porcelain crowns that match the patient's age, sex, and personality and help bring out those indefinable characteristics that make each of us so different. We have an opportunity to reshape the crowns when they are inserted in the pa-

tient's mouth at the stage of the biscuit bake. The contour of the mesial, distal, labial, and buccal surfaces is shaped in the mesiodistal, buccolingual, and gingivo-incisal planes. It is always necessary to stain the occlusal and buccal grooves, the cemento-enamel junction, and other areas on the buccal and labial surfaces as indicated for each adult patient. The age, sex, and personality of the patient are the determining factors, and it is the responsibility of the dentist to prescribe the

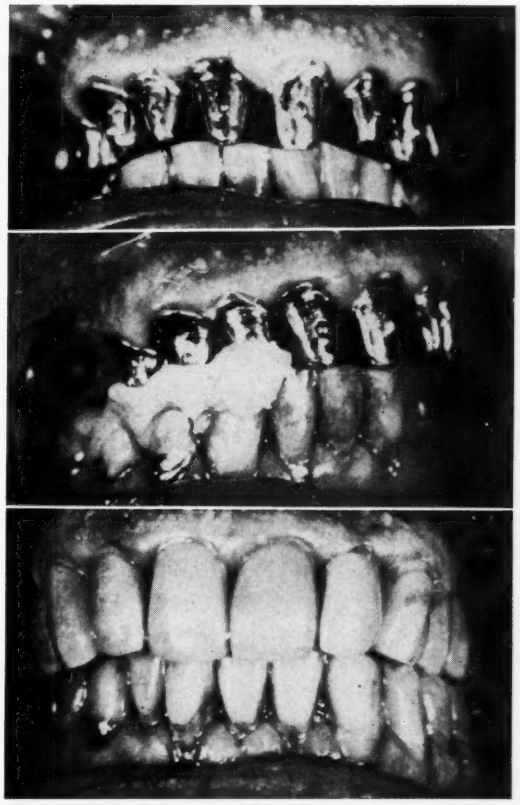


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 1.—Iridio-platinum castings are in position in the mouth. Note the "buttons" on the labial and buccal surfaces.

Fig. 2.—The interocclusal centric relation record is made in acrylic resin. The acrylic resin on the lower castings has been thinned so that its extent can be seen.

Fig. 3.—The crowns are of porcelain fused to iridio-platinum castings. Note the healthy condition of the gingivae as well as the esthetics of the finished restorations.

amount, location, extent, intensity, and shade of the stains. I prefer to stain the lingual surfaces of all teeth and the incisal edges of the anterior teeth. The staining varies from a stain so delicate as to be almost unnoticeable to one so obvious that the most untrained and casual observer sees it immediately. The staining may be in very thin delicate lines or it may cover broad areas of the tooth. The only guide is the finely developed esthetic sense of the dentist.

SUMMARY

The maintenance of healthy tone and contour of the gingival tissues around crowns is of the utmost importance, and the correct fit of the iridio-platinum casting to the tooth makes for the best possible result (Fig. 3). Porcelain is the material of choice when esthetics is of primary importance. Porcelain fused to iridio-platinum is a material which can be used to fulfill both the functional and esthetic requirements. The material, when properly used, lends itself to the ultimate in modern dentistry.

1775 Broadway
New York 19, N. Y.

INCISAL AND CONDYLAR GUIDANCE IN RELATION TO CUSPAL INCLINATION IN LATERAL EXCURSIONS

LAWRENCE A. WEINBERG, A.B., D.D.S.
Brooklyn, N. Y.

BASIC LAWS of motion and mandibular guidance should be familiar to the dentist before articulators can be evaluated as to their ability to imitate physiologic motion. The basic relationships of the incisal and condylar guidances to the cusp inclines in lateral excursions will be discussed.

GUIDANCE OF MOTION

A three-dimensional object must have at least three separate points of guidance to orient and describe its motion. The balancing and working condyles form two of the required three points of guidance for lateral excursions. Without tooth contact, the musculature of the mandible (the muscle complex) acts as the third point of guidance for lateral movements. The muscle complex attaches in many different areas of the mandible and has many different directions of action. We can visualize as well as record the coordinated lateral movements produced by these muscles by watching one fixed point at the incisors (Fig. 1).

Lateral Movements With Tooth Contact.—Mechanically, the teeth are in a more favorable position than the muscle complex. When the teeth are in contact, they take preference over the muscle complex as the third point of guidance for the mandible during lateral excursions. The incisal guidance then acts as the required third point of guidance with the balancing and working condyles.

Balancing Condylar Movement.—The balancing condyle moves anteriorly and medially during mandibular excursions to the opposite side (Fig. 1). The vertical angulation of its anterior and medial movement depends on the temporomandibular joint anatomy. The degree of medial movement is related to the individual type of working-side condylar movement. The more lateral movement in the working condyle, the more medial the direction of the balancing condyle. The incisal guidance does not determine the condylar path. However, the condyles do have a direct influence on each other.

CONDYLAR MOVEMENT PATTERN

Protrusive Movement.—The pattern of normal condylar movement is fairly constant throughout adult life. Protrusive movements are anterior in nature, with a characteristic degree of vertical inclination depending on the individual joint anatomy. If the path of one condyle is markedly flat, the anteroposterior occlusal plane on that side is usually flattened and has a decreased compensating curve.

Received for publication Sept. 23, 1958.

Working Condyle During Lateral Movement.—Three clinical observations indicate the rotational component of the working-side condyle. First, in lateral excursions the working-side condyle does not move as great a distance as the balancing-side condyle; second, the lower anterior teeth move a greater distance than the posterior working-side teeth; third, the facets on the working-side posterior teeth are shorter in length than the facets on the anterior teeth. Lateral movement *alone* would produce equal movement of these various points. Thus, rotation plays a part in the working condylar movement.

Theoretically, three types of working condylar motion are possible. These are: (1) rotation with little lateral movement, (2) rotation with lateral movement with a zero degree of inclination, and (3) rotation with lateral movement with some degree of inclination. Just as each individual varies in protrusive condylar inclination, depending on his joint anatomy, so will every patient have a characteristic type of right and left lateral working-side condylar movement.

An individual who has rotation with little lateral movement of the working condyle will reflect more of an anterior movement of the opposite balancing condyle. A working condyle that rotates with more lateral movement will cause the opposite balancing condyle to move anteriorly but with more of a medial component (Fig. 2). A working condyle that rotates with an inclined lateral movement causes the opposite balancing condyle to move anteriorly but with less of a medial component (Fig. 3).

Articulators.—Most simple adjustable articulators (like the Hanau) provide for only a rotating working-side condyle with a lateral shift at zero degree inclination. This is an important consideration since it affects the working cuspal inclination. The Gnathoscope reproduces whatever working condylar path exists by two "Bennett guides" that usually have to be ground in for each patient. The three general types of working condylar movements can be demonstrated clinically on the Gnathoscope.*

THE RELATION OF THE INCISAL GUIDANCE TO THE CONDYLAR PATHS IN LATERAL EXCURSION

A change in the incisal guidance will not necessarily alter the working and balancing condylar paths once they have been established.[1,2] A specific resultant mandibular movement occurs in response to the three extreme guidances: the incisal guidance and the working and balancing condyle paths (Fig. 4). When the

*Cohen, R.: Personal communication.

Fig. 1.—*(A)* The balancing-side and *(B)* the working-side condyles form two of the required three points of guidance for lateral excursions. The coordinated lateral movements produced by the muscles can be visualized by watching one fixed incisal point *(C)*.

Fig. 2.—A working-side condyle that rotates with lateral movement causes the opposite balancing-side condyle to move anteriorly with a more medial component.

Fig. 3.—A working-side condyle that rotates with an inclined lateral movement causes the opposite balancing-side condyle to move anteriorly but with less of a medial component.

Fig. 4.—*(M)* A specific resultant mandibular movement occurs in response to the three extreme guidances: the incisal guidance and the working and balancing condylar paths. The condylar paths are not altered by changes in incisal guidance.

Fig. 5.—A change in mandibular motion *(M)* results when the inclined incisal guidance is changed to a flat plane. The working-side and balancing-side condyles do not necessarily change their paths with a change in incisal guidance.

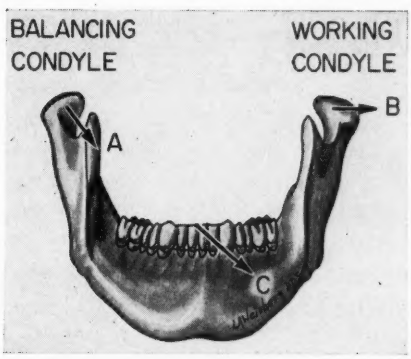


Fig. 1.

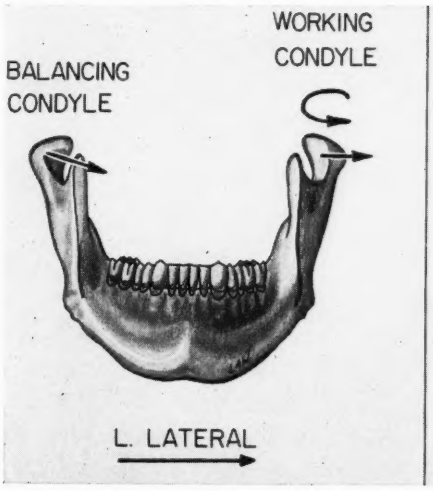


Fig. 2.

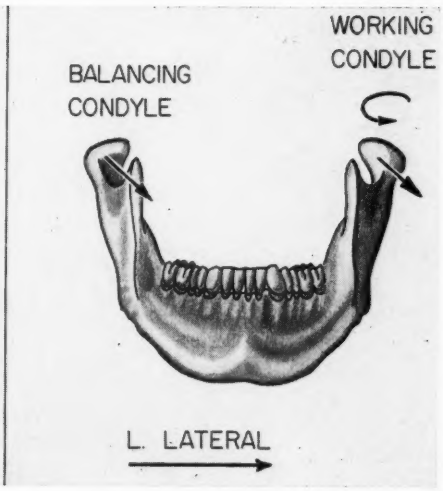


Fig. 3.

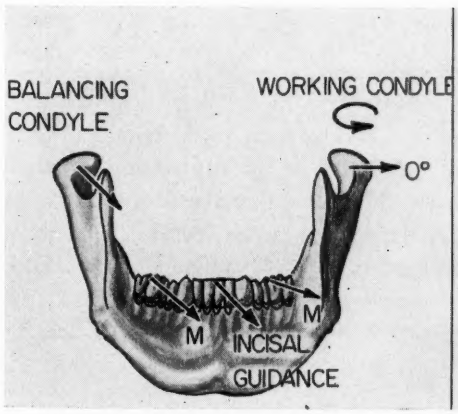


Fig. 4.

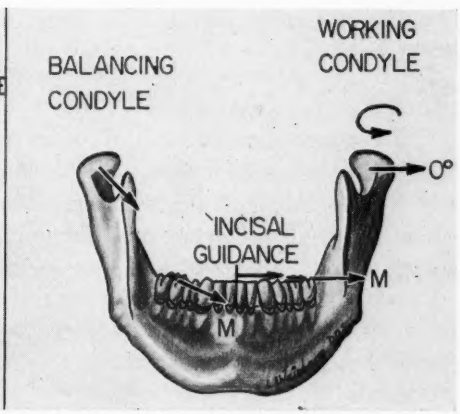


Fig. 5.

Figs. 1 to 5.—*For legends, see facing page.*

inclined incisal guidance is changed to a flat plane, a change in mandibular motion results. However, the working and balancing condyles *do not* change their path with a change in incisal guidance (Fig. 5).

THE RELATION OF THE INCISAL-CONDYLAR GUIDANCE TO BALANCING-SIDE CUSP INCLINES

To facilitate discussion, the balancing-side condyle, the balancing cusp inclines, and the incisal guidance are considered to be in a straight line. The balancing cusp inclines must harmonize with the two extreme guidances (condylar and incisal), depending on their relative position to each. For example, if the balancing-side condyle and the incisal guidance both have a 30 degree inclination, all of the

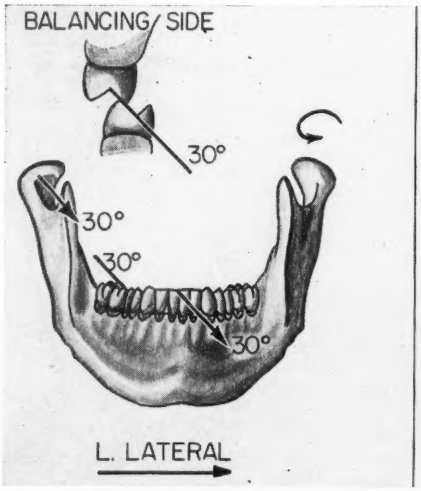


Fig. 6.

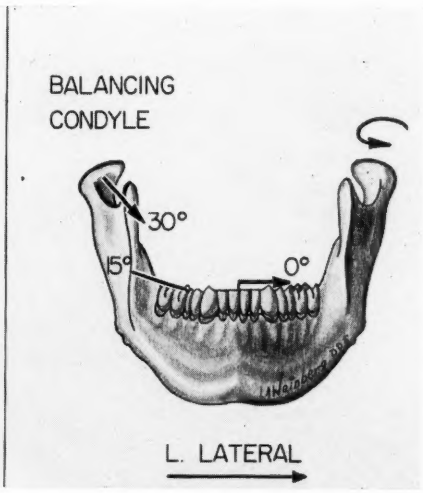


Fig. 7.

Fig. 6.—A 30 degree inclination of the balancing condyle and the 30 degree incisal guidance result in a 30 degree inclination of all the balancing cusp inclines.

Fig. 7.—When the incisal guidance is zero degree and the balancing condylar path is 30 degrees, the balancing inclines at the midpoint near the second molar are approximately 15 degrees.

balancing cusp inclines will have the same 30 degrees inclination (Fig. 6). However, if the incisal guidance is zero degree and the balancing-side condylar path is 30 degrees, the midpoint near the second molar will be approximately 15 degrees (Fig. 7). In this instance, the more anterior the tooth, the less its balancing cusp inclination. The balancing cusp inclination is related to its location between the balancing-side condylar path and the incisal guidance.

THE RELATION OF THE INCISAL-CONDYLAR GUIDANCE TO THE WORKING-SIDE CUSP INCLINES

Physiologic working condylar motion cannot be classified strictly into one of the three types of working-side condylar motions. Patients can exhibit working condylar motion that falls between these classifications. Certainly we should also

expect different left and right working-side condylar paths on the same patient. The classification is presented to help us understand more about mandibular motion and the principles of articulators and their possible deficiencies.

Working-side Condylar Motion, Rotational Type.—Without Gnathologic means, it is difficult to accurately determine the type of working-side condylar motion. Usually a deep temporomandibular fossa with a steep anteroposterior condylar path is associated with a steep incisal guidance, a compensating curve with a short radius, and a more rotational type of working condylar motion. A flattened transverse curve is associated with limited lateral movement of the working-side condyle, while the balancing-side condyle moves anteriorly with little medial movement. The distance the teeth move against their antagonists on the working side is dependent on their relative location between the rotating working-side condyle and the incisal guidance. The more posterior the tooth, the less the distance traversed. This is similar to any rotation; the closer to the center, the less the movement.

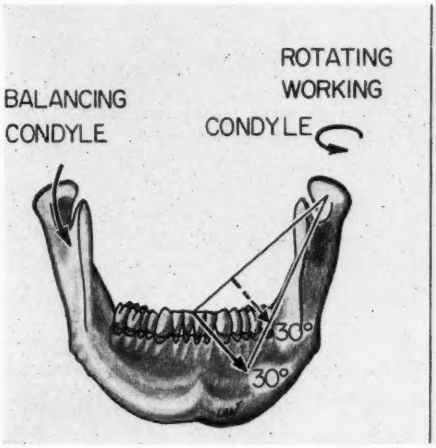


Fig. 8.

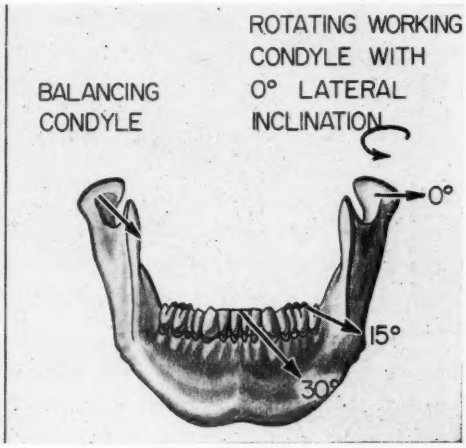


Fig. 9.

Fig. 8.—When the working side condyle has almost entire rotation with little lateral movement, the working inclines have similar angulation (30 degrees) to the incisal guidance (30 degrees).

Fig. 9.—A rotating working-side condyle with a lateral shift at zero degree inclination is shown. When the incisal guidance is 30 degrees, the working inclines at the midpoint near the second molar are the average between zero degree and 30 degrees, or namely 15 degrees.

If the working condyle has almost complete rotation with little lateral movement, the working inclines will have similar angulation to the incisal guidance (Fig. 8).

Rotating Working-side Condyle With a Lateral Shift.—The whole working-side cuspal relationship changes if the working-side condyle shifts laterally as it rotates at zero degree inclination. The balancing-side condyle still moves anteriorly, but it has a more medial component to accommodate the lateral shift of the working-side condyle. For example, if the incisal guidance remains at 30 degrees, the working-side inclines at the midpoint near the second molar will be the average between zero degree and 30 degrees, or 15 degrees (Fig. 9).

Rotating Working Condyle With an Inclined Lateral Shift.—The mandibular relationship is further modified if the working condyle moves at a lateral inclination as it rotates. If the rotating condyle shifts laterally at 15 degrees inclination and the incisal guidance is 30 degrees, the midpoint would be approximately 23 degrees (Fig. 10). The opposite balancing condyle would move anteriorly but with less medial component than when the working condyle shifted laterally with no inclination (Fig. 9).

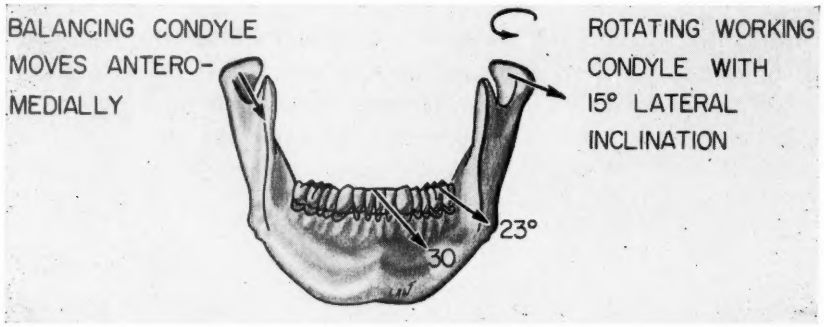


Fig. 10.—When the rotating condyle shifts laterally at 15 degrees inclination and the incisal guidance is 30 degrees, the working inclines at the midpoint are approximately 23 degrees.

Clinical Significance of the Working Condylar Motion.—With the same incisal guidance (30 degrees), different types of working-side condylar motions produce changes in the working cusp inclination. The second molar working inclines, for example, varied from half the incisal guidance (15 degrees) to the equivalent of the incisal guidance (30 degrees).

If the molar cusp incline is 3 mm., a difference of 15 degrees in cuspal inclination would result in an error at the cusp height of 0.78 mm. It will require extensive study to evaluate what effect an error in the cusp height of up to 1.0 mm. can have on the muscle complex and on the temporomandibular joints.

THE TRANSVERSE CURVE IN RELATION TO THE CONDYLAR-INCISAL GUIDANCE FOR LATERAL EXCURSIONS

Working-side Condylar Influence.—The relationship of the working and balancing cusp inclines forms the transverse curve. From the front view, the transverse curve is established by two excursions, the left and right lateral movements. The type of working-side condylar movement influences the working cusp inclines. If the rotating working-side condyle moves laterally, the working inclines will have less inclination than the balancing inclines (Fig. 11). When the same situation exists for the opposite lateral movement, the bilateral steep balancing cusp inclination forms a transverse curve (Fig. 12). The transverse curve, therefore, is associated with rotating and lateral shifting working-side condyles. It is the lateral shifting element of the working-side condyle that is of significance in producing the transverse curve.

Practical Conclusions on the Transverse Curve.—A flat transverse curve in natural teeth is more the exception than the rule. The upper buccal and lower lingual axial inclinations of the teeth establish the transverse curve. More often the balancing-side condyle has a greater inclination than the working-side condyle. With an average incisal guidance, the balancing cusp inclines would, therefore, have a steeper inclination than the working cusp inclines (Fig. 11). This is repeated during the opposite lateral excursions producing the typical transverse curve seen in Fig. 12. The key to this pattern is the relationship of the balancing-side and working-side condylar motion in bilateral movements rather than the incisal guidance.

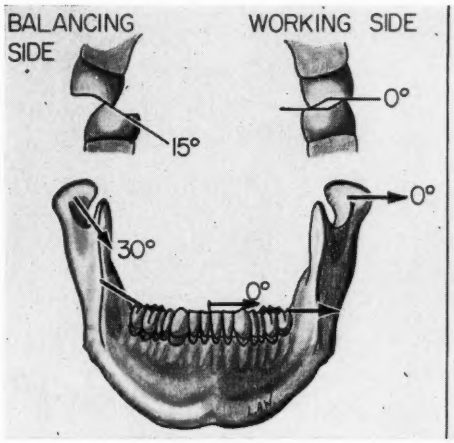


Fig. 11.

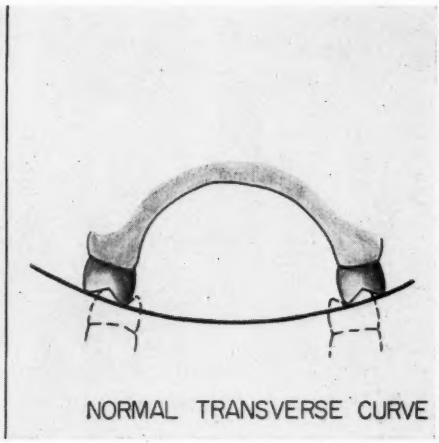


Fig. 12.

Fig. 11.—When the incisal guidance is zero degree and the balancing condylar path is 30 degrees, the balancing cusp inclination at the midpoint will be 15 degrees. On the working side the cusp inclination is zero degree because of the lateral shift of the working condyle.

Fig. 12.—When both working-side condyles have a lateral shift, the bilateral steep-balancing cusp inclination forms a transverse curve.

The Reverse Transverse Curve.—Unfortunately, many prosthodontists draw the wrong conclusions from observing the end product of exaggerated occlusal wear in certain patients who exhibit a reverse transverse curve (Fig. 13). Their rationale is that since nature produced this pattern (after years of wear), it is more "physiologic" and, therefore, should be provided at the time of therapy for denture patients. It is even recommended for natural teeth in reconstruction. Furthermore, the method of occlusal equilibration is changed to the lower buccal and upper lingual cusps since these are the cusps that wear more rapidly.[3,4]

In the dentition the upper lingual and lower buccal cusps wear more rapidly for two reasons: (1) during bruxism they are always in contact against an inclined plane which wears more slowly since it is abraded only where it is contacted by the cusp, and (2) in mastication these particular cusps receive more abrasion than the opposing occlusal inclines.[5] The efficiency of the chewing surface is in a large part dependent upon the action of the upper lingual cusp inclines

which hold the bolus on the occlusal table.[5] As the reverse curve develops, the dentition becomes more inefficient because the food passes lingually too easily.

One can draw the erroneous conclusion that this type of occlusion does not seem to break down the periodontium. However, if the alveolar bone support were weak, the teeth would have been lost long before this much wear could develop. Therefore, we incorrectly associate good periodontal support with this type of wear; we are observing only the periodontal resistant type of patient. Such severe wear

Fig. 13.

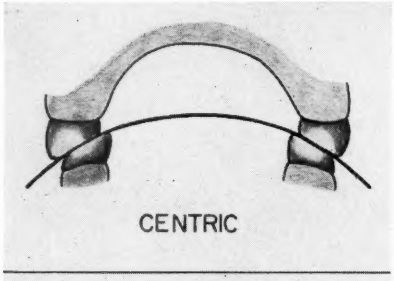


Fig. 14.

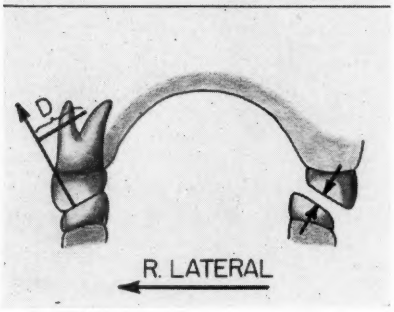


Fig. 13.—The reverse transverse curve is the end product of exaggerated occlusal wear. The lower buccal and upper lingual cusps wear more rapidly than their antagonists.

Fig. 14.—Vertical occlusal pressure in centric position or lateral excursion results in a force that falls at a great distance *(D)* from the center of rotation of the tooth which produces lateral stress. There is no balancing contact with this type of occlusion.

shortens the crown to root ratio which helps resist the occlusal pressures. If physiologic eruption does not keep pace with the wear, a reduction in the vertical dimension of occlusion takes place which lessens the amount of muscular power that can be applied to the teeth.

Another important fact that is overlooked is that more lateral torque develops with this type of occlusion. As the lower buccal and the upper lingual cusps wear, the occlusal inclination increases. Vertical occlusal pressure in centric position or lateral excursion results in a force perpendicular to the occlusal incline. This force falls at a great distance from the center of rotation of the tooth which produces more torque (Fig. 14).

The occlusal table widens with this type of wear which brings the forces further lateral to the base of the alveolar support. During bruxism as the jaw moves into

lateral excursions, the balancing side has no contact (Fig. 14). This is often the case in natural teeth and in itself is of no consequence. Due to the lateral component of the working-side condylar rotation, greater lingual cusp inclination is necessary for occlusal balance (Fig. 11). Since there is no lingual cusp in this type of occlusion, no balancing contact can be expected.

Dentures.—To arrive at balanced occlusion in denture construction, a balancing ramp would have to be constructed to conform with the condylar movement in lateral excursions. The reverse transverse curve of occlusion in denture construction has several disadvantages: (1) it is less efficient, (2) more lateral torque is produced due to the upper buccal cusp inclination, (3) the occlusal table is widened, and (4) a balancing ramp must be provided for occlusal balance rather than a continual balance on all lingual cusp inclines.

Fig. 15.

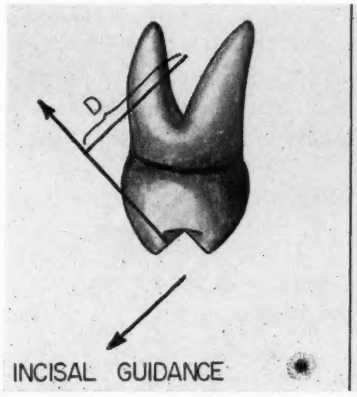


Fig. 16.

Fig. 15.—A steep incisal guidance produces a resultant line of force that falls at a great distance *(D)* from the center of rotation of the tooth. This force produces torque.

Fig. 16.—The cusp inclines are decreased proportionately with a reduction in incisal guidance. The resultant line of force falls closer *(d)* to the center of rotation of the tooth and effectively reduces the torque.

Occlusal Equilibration.—Occlusal equilibration for natural or artificial teeth for lateral excursions should follow the classical formula of grinding the buccal cusp inclines of the upper and the lingual cusp inclines of the lower teeth.[6-11] The incorrect procedure of grinding *only* the lower buccal and the upper lingual cusps to eliminate centric occlusal prematurities can result in the loss of lateral contact. These cusps should be corrected only when they also contact prematurely in lateral eccentric positions.

RESULTANT OCCLUSAL FORCES WITH CHANGES IN INCISAL GUIDANCE

A decrease in the incisal guidance results in a decrease in the working and balancing cusp inclines, which reduces the lateral torque. Vertical occlusal force, whether it occurs in centric occlusion or lateral excursions, produces a line of force perpendicular to the particular cusp incline (Fig. 15). With a steep incisal guidance, the resultant line of force falls at a great distance from the center of rotation of

the tooth producing the torque. As the incisal guidance is reduced, the cusp inclines are decreased proportionately. The resultant line of force falls closer to the center of rotation of the tooth, effectively reducing the torque (Fig. 16).

Muscle Complex.—A reduction of the incisal guidance in the dentition does not necessarily change the condylar path, but it does change the resultant mandibular motion. For periodontally involved teeth, a reduction in the incisal guidance (which reduces cusp inclines) reduces the lateral stress to the teeth (Figs. 15 and 16). The tolerance of the muscle complex must not be exceeded. Marked reduction of the incisal guidance without accurate condylar reproduction on the articulator, followed by occlusal equilibration in the mouth, affects the condylar paths as well as the muscle complex.

THE MUSCLE COMPLEX IN RELATION TO THE TEMPOROMANDIBULAR JOINT IN LATERAL EXCURSIONS

Without tooth contact, lateral jaw movements are controlled by the two condyles and the muscle complex which acts as the third point of guidance (Fig. 1). The joints and musculature develop and function together as a physiologic unit and, without some other stimulus, usually do not develop functional pathology.

INCISAL GUIDANCE IN RELATION TO LATERAL JAW MOVEMENT

Teeth in contact take preference over the muscle complex as the third point of guidance for lateral jaw movements because of their mechanically efficient position. We can change the incisal guidance without necessarily changing the condylar paths (Figs. 4 and 5). However, the new mandibular motion may not be in harmony with the muscle complex during lateral excursions. If the tolerance of the muscle complex is exceeded, pathology will develop.

Clinical Implications.—Some will disagree that changing the incisal guidance does not necessarily change the condylar paths in lateral excursions. However, experimentation with objects and reference to Figs. 4 and 5 will convince most readers that this is true. The movable denture base eliminates a good deal of the problem with denture patients as the teeth do not usually take preference over the muscle complex.

The teeth do take preference over the muscle complex in complete mouth reconstruction, and a change in incisal guidance will not necessarily change the condylar paths in lateral excursions (Figs. 4 and 5) if a Gnathoscope is utilized. This depends on the accuracy of the centric relation mounting. With other less complicated adjustable instruments, such as the Hanau articulator, a change in the incisal guidance not only changes the mandibular motion (which affects the muscle complex) but it *can* change the condylar paths as well.

Final occlusal equilibration in the mouth is essential for any patient. The occlusal equilibration in the mouth should be much less extensive with Gnathologic construction because the small error in lateral excursions is produced only by the slight discrepancy in the original centric relation mounting. With the Hanau articulator, the same small error due to the centric relation mounting is present along with that which is produced by the approximated condylar paths. The con-

dylar inclinations, the location of the vertical axes, and the individual type of working-side condylar movement are all approximated. These errors can be corrected only in the mouth.

DEVELOPMENT OF THE DENTITION IN RELATION TO THE MUSCLE COMPLEX AND TEMPOROMANDIBULAR JOINTS

Lateral excursions produced by the temporomandibular joints and the muscle complex create lateral forces, via the cusp inclines, which help guide the erupting teeth into harmonious positions. Habits, heredity, and tooth loss or retention can cause the faulty positioning of the erupting teeth. The teeth in contact have preference over the muscle complex and even the temporomandibular joints if the disharmony is traumatic enough. When the tolerance of one or more of the three elements of the system (teeth, muscle complex, and temporomandibular joints) is exceeded, pathology will result.

CLINICAL REQUIREMENTS TO PRODUCE HARMONIOUS RELATIONSHIPS

One transverse hinge axis exists; therefore, the Gnathoscope or the Hanau type of adjustable articulator is preferred for laboratory imitation of mandibular movements.[12] A Gnathologic hinge axis or a Hanau face-bow mounting is required for maxillary cast orientation. The Gnathoscope can duplicate accurately the working condylar motion whether it is mostly rotation, rotation with lateral movement, or rotation with laterally inclined movement. Simple adjustable articulators such as the Hanau are capable only of working-side condylar rotation with lateral movement at zero degree inclination.

Final occlusal equilibration is necessary in the mouth in complete mouth reconstruction by Gnathologic means because of the small error in the centric relation mounting and cast construction. Relatively more oral corrective procedures are necessary with a Hanau articulator since the position and paths of the condyles are estimates of the actual physiologic conditions.

SUMMARY

Some theoretic aspects of the incisal and condylar guidances in relation to the cusp inclines for lateral excursions have been presented. Since most patients exhibit signs of bruxism,[13] we must know more about the various guidances of the mandible that produce harmonious cuspal inclines in lateral excursions. These guidances have been related to the basic clinical problems of articulators.

REFERENCES

1. Cohen, R.: The Relationship of Anterior Guidance to Condylar Guidance in Mandibular Movements, J. Pros. Den. **6**:758-767, 1956.
2. Weinberg, L. A.: The Occlusal Plane and Cuspal Inclination in Relation to Incisal-Condylar Guidance for Protrusive Excursions, J. Pros. Den. **9**:607-618, 1959.
3. Jankelson, B.: Physiology of the Human Dental Occlusion, J.A.D.A. **50**:664-680, 1955.
4. Shanahan, T. E. J.: The Individual Occlusal Curvature and Occlusion, J. Pros. Den. **8**:230-240, 1958.
5. Weinberg, L. A.: Force Distribution in Mastication, Clenching, and Bruxism, D. Digest, **63**:58-61, 116-120, 1957.

6. Blass, J. L.: Occlusal Equilibration in Periodontal Treatment, New York D. J. **22**:121-129, 1956.
7. Miller, S. C.: Textbook of Periodontia, ed. 3, Philadelphia, 1950, The Blakiston Co., pp. 343-384.
8. Sorrin, S.: Traumatic Occlusion, Its Detection and Correction, D. Digest, **40**:170-173, 202-208, 1934.
9. Simring, M.: Occlusal Equilibration of the Dentition, J.A.D.A. **56**:643-655, 1958.
10. Schuyler, C. H.: The Correction of Occlusal Disharmony of the Natural Dentition, New York D. J. **13**:545-562, 1947.
11. Weinberg, L. A.: A Visualized Technique of Occlusal Equilibration, J. D. Med. **7**:9-26, 1952.
12. Weinberg, L. A.: Transverse Hinge Axis: Real or Imaginary, J. Pros. Den. **9**:775, 1959.
13. Weinberg, L. A.: Occlusal Equilibration in Eccentric Positions, New York State D. J. **23**:310-312, 1957.

515 Ocean Ave.
Brooklyn 26, N. Y.

THE TELESCOPIC TYPE OF FIXED PARTIAL DENTURE ABUTMENT

GERALD J. STEINBERG, D.D.S.

Temple University, School of Dentistry, Philadelphia, Pa., and Georgetown University, School of Dentistry, Washington, D. C.

A TELESCOPIC TYPE of fixed partial denture pontic abutment can be used when it is not possible to parallel the preparations of abutment teeth. Generally, this type of abutment is necessary in order to parallel the walls of third molar teeth with those of cuspids and bicuspids.

Third molars commonly have a severe mesial tilt because of the premature loss of the first and second permanent molars. Similarly, there is often a severe distal drift of the cuspids because of the loss and nonreplacement of the bicuspids (Figs. 1 and 2). To parallel the preparations of such teeth for abutments is impossible. Therefore, it is necessary to devise a fixed partial denture abutment that can be inserted with the precision parallelism necessary for the completed prosthesis.

TELESCOPIC PONTIC

A telescopic pontic is used to achieve this goal. A telescopic pontic is a complete gold casting shaped and formed like a preparation for a full cast veneer crown with a shoulder. The clinical tooth shape fits over this pontic and is cemented to it. The telescopic pontic is a cantilever pontic which, following the casting, is finished completely but not polished. The walls of this pontic can be made parallel with any other abutment (Figs. 3 and 4). This affords an excellent surface for cementation of the fixed partial denture.

To gain adequate strength in this type of fixed partial denture, all abutment teeth should be prepared and utilized as full cast veneer crowns. The telescope pontic preparation is made similar to a veneer crown preparation (Fig. 5) and is utilized as an abutment in exactly the same manner as simple routine fixed partial denture abutments.*

ATTACHING THE TELESCOPIC PONTIC

The individual parts of the fixed partial denture are fabricated in the usual manner. The telescopic pontic is positioned on the cast in the correct alignment

Received for publication Oct. 21, 1958; revised by the author Jan. 22, 1959.
*Merril, A.: Personal communication.

Fig. 1.

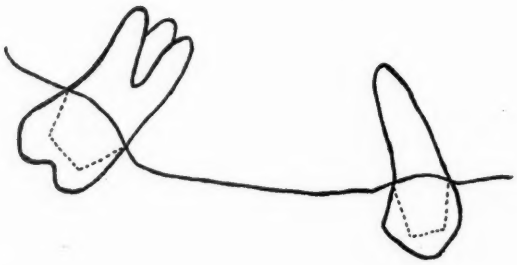


Fig. 2.

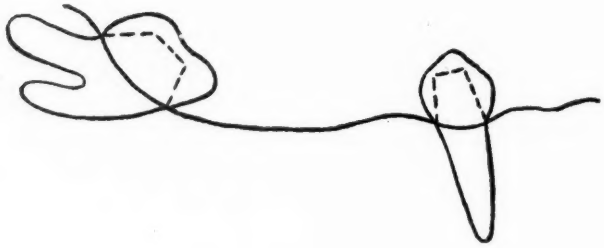


Fig. 3.

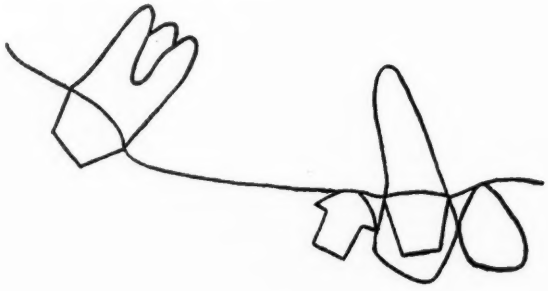


Fig. 4.

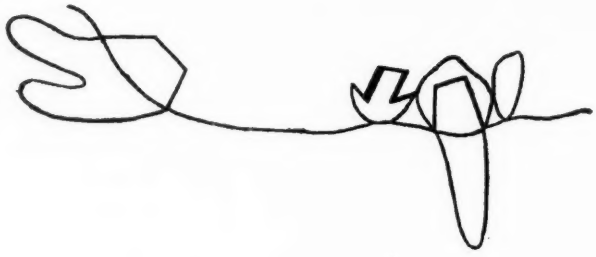


Fig. 1.—Preparations on these teeth cannot be made parallel because of the inclination of the teeth. The dotted lines indicate the shape of the preparations.

Fig. 2.—The preparations on these lower teeth cannot be made parallel.

Fig. 3.—A cantilever pontic which is shaped like a veneer crown preparation is attached to the crown on the anterior abutment tooth. The pontic is shaped so that its walls are parallel to the walls of the preparation on the molar tooth.

Fig. 4.—A cantilever pontic is added to the crown on the anterior abutment tooth. The tapered walls of the pontic are made to parallel the walls of the preparation on the molar.

with the other abutment preparation. Parallelism is insured by means of a parallelometer. The telescopic pontic may be soldered to an adjacent crown on the opposite side if such a crown is present.

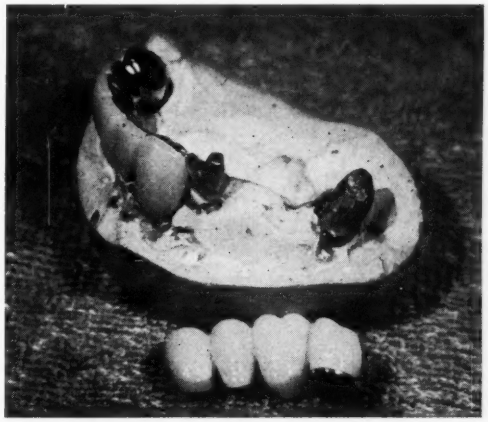


Fig. 5.—The telescopic pontic is attached to the distal side of the cuspid pontic. The bicuspid pontic fits over the cantilever pontic, and its inner walls are parallel to the preparation on the molar tooth.

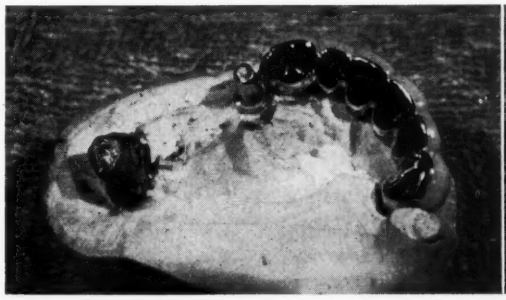


Fig. 6.

Fig. 7.

Fig. 6.—The anterior section of the restoration with the cantilever telescopic pontic is completed and returned to the cast.

Fig. 7.—The posterior section of the restoration is completed, and both sections are prepared for cementation.

COMPLETING THE FIXED PARTIAL DENTURE

Following the correct aligning of the abutments, full cast veneer crowns are constructed. The telescopic pontic is used as if it were a simple die in the cast. The crown is waxed to the pontic, and allowance is made for the labial surface to be veneered. The completed wax-up is removed and cast in gold. The finished casting is returned to the cast along with the casting for the other abutment teeth. Then the pontics are fabricated and soldered to the two veneer castings. The facings are completed in the veneered material (Figs. 6 and 7).

SUMMARY

The nonparallelism of abutment tooth preparations can be overcome by utilizing the telescopic pontic. The technique for the use of this telescopic pontic as an abutment for a fixed partial denture is described.

530 Oglethorpe St., N. E.
Washington 11, D. C.

PRACTICAL APPLICATION OF TOOTH MORPHOLOGY

CHARLES SCHROETER*
University of Washington, School of Dentistry, Seattle, Wash.

PROPER TOOTH ANATOMY is necessary in most restorations for several reasons. Good tooth form will prevent overloading of the teeth; it will promote self-cleansing and hygienic properties, thereby contributing to the self-preservation of the teeth; it is invaluable for masticatory efficiency; it is necessary to create results which are harmonious from an esthetic standpoint; it will add to the patient's comfort.

Frequently the question arises, should minute anatomic detail be incorporated into every restoration? The answer depends largely on the esthetic and functional demands of the patient and on the ability of the dentist. The anatomy of the unrestored remaining teeth and the condition of the investing tissues will generally determine the required amount of anatomy for an individual carving. It is not possible or advisable to incorporate all anatomic features into every dental restoration. Moderate tooth anatomy in heavily abraded teeth will create a functionally more efficient restoration and lessen the load on the teeth. Restorations without anatomy are not indicated simply because the remaining teeth have no detailed anatomic features.

Whatever the value the dentist ascribes to good tooth form, he should know how to incorporate the desired anatomy into restorations expeditiously. It is the purpose of this article to describe the practical use of the principles of tooth morphology that occur in the natural dentition.

CONCEPT

A sound mental image or concept of tooth morphology must exist before reproduction of a correct anatomic tooth form or tooth replacement is possible. Acquisition of this concept demands the recognition of numerous visible differences of the teeth which can be classified as (1) proportion, (2) outline, (3) angles, and (4) surfaces. Looking for visible differences in teeth greatly increases an in-

Read before the Tenth Pacific Coast Dental Conference, San Diego, Calif., Aug. 22, 1957.
Received for publication Sept. 6, 1958.
*Assistant Professor of Oral Anatomy, Department of Operative Dentistry.

dividual's power of observation and is of practical value when esthetic and functional features are reproduced critically.

The dimensional rectangle and the fundamental geometric shape which is derived from the rectangle are convenient adjuncts for the analytic treatment of visible differences in tooth form. The dimensional rectangle determines the correct proportion, and the fundamental geometric shape determines the characteristic outline form of the individual tooth (Fig. 1). These shapes can be memorized readily. In addition, anatomic features of the teeth are classified according to characteristics which are common to all teeth or to a particular group of teeth.

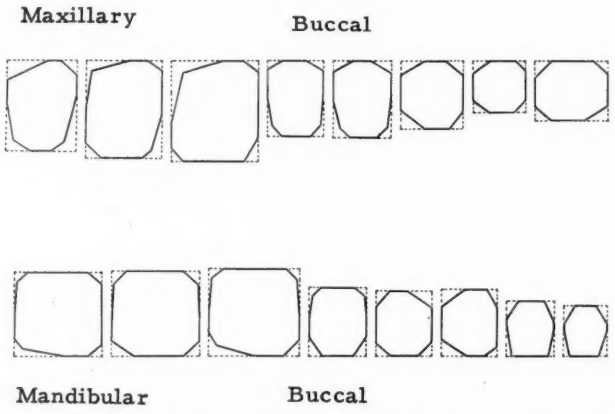


Fig. 1.—The dimensional rectangles and the fundamental geometric shapes of the permanent teeth in the maxillary and mandibular right quadrants as seen from the occlusal surface.

The visible differences, the dimensional rectangle, the fundamental geometric shape, and the classified characteristics compose a concept of tooth anatomy which is the basis for a systematic carving procedure.

There is no better model to copy than natural teeth. However, the smallness of the tooth and the light reflecting qualities of the enamel make the finer details difficult to see. Study casts of well-formed teeth can be kept and used for reference while carving restorations or wax patterns.

ESTHETICS

Good tooth anatomy is not difficult to carve when a normal relationship exists between the maxillary and mandibular teeth. The opposing teeth determine the length of the incisal ridge or cusp and the slope of the triangular ridges by normal intercuspation in all possible excursions. The central groove, the pits, and the developmental grooves fall into their proper places (Fig. 2, *A*).

A minor shift from a normal cusp relationship still allows the carving of acceptable tooth form, although some of the anatomic landmarks will have to be shifted slightly (Fig. 2, *B* and *C*).

The cusp upon cusp relationship is the most difficult when good occlusal anatomy must be carved. The anatomic landmarks are greatly subdued and the carving resembles an abraded tooth (Fig. 2, *D*).

An esthetic result is difficult when the available space for a full-tooth replacement is either too wide, too narrow, too short, or too long. The proportion of the restoration will be abnormal. The axial alignment, the length and the angulation of the incisal ridges or cusp ridges, the faint indication of a cervical line, a proximal overlap, or a stained cervical abrasion in suitable combinations can counterbalance the existing condition and permit the development of a harmonious piece of work.

The shade of a restoration or facing is important. However, the emphasis should be placed on the inclusion of the relief features of the labial or buccal

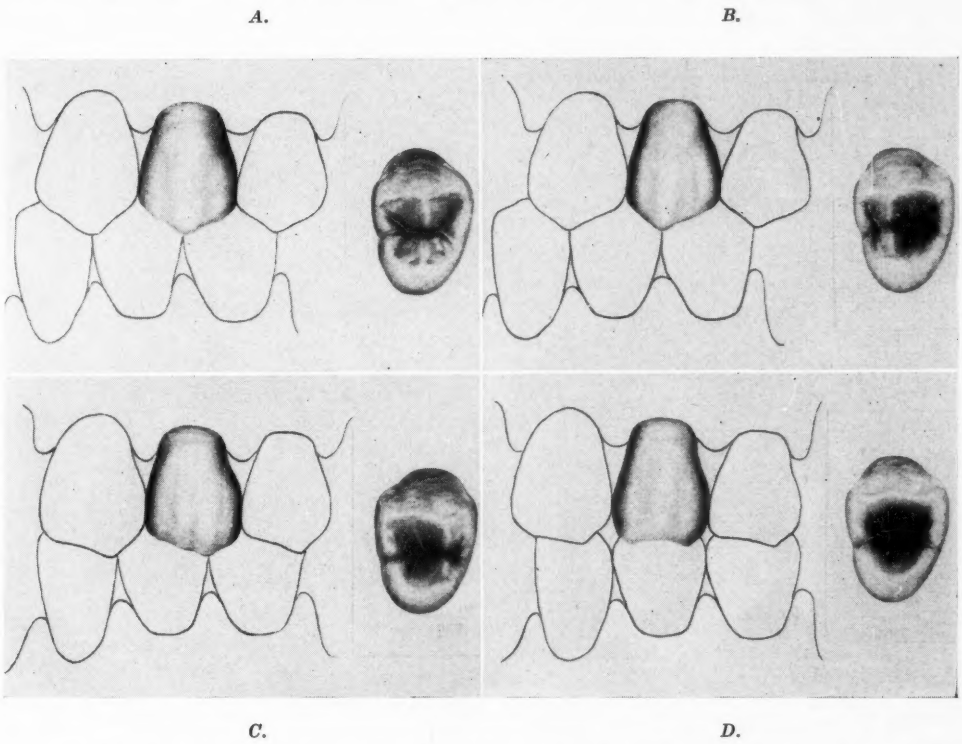


Fig. 2.—The suggested anatomy for practical carving of facial and occlusal surfaces under various maxillomandibular cusp relationships. *A*, Normal intercuspation. *B*, Anterior shift. *C*, Posterior shift. *D*, Cusp-to-cusp relationship.

surface, an accurate outline, and the proper labial contour of the facing. A stock facing which has not been changed to meet the existing anatomic requirements can be detected immediately no matter how beautifully the shade is matched.

The natural difference in the convexity between the mesial and distal outline should be carefully reproduced in a facing. The distal outline is usually more convex. Also, the cervical contour must correspond to that of the other teeth.

The labial surface characteristics should receive special attention because these anatomic features aid in reflecting light and create an intrinsic blending effect. Shallow labial developmental grooves usually separate the lobes, and incremental lines at the cervical third and additional horizontal developmental markings extend

across the tooth surface. These anatomic features contribute to a restoration of harmonious appearance (Fig. 3).

FUNCTIONAL CONSIDERATIONS

The jaw relation registrations, the excursions of the opposing teeth, and the fundamental geometric shape actually determine the gross anatomy of the restoration. For function and esthetics, the over-all shape or gross anatomy is frequently rechecked for contour. Only after the general alignment, contour, and function are established are the detailed anatomic features incorporated. The guiding rules are: (1) the fossae must be wide, (2) the cusps must be separated, (3) the marginal ridges must be rounded, (4) the contact area must be broad, (5) the developmental and supplemental grooves must be definite but not deep, and they usually fade out into shallow depressions as they swing toward the cusp height, (6) the axial and occlusal spillways must form definite escapements, and (7) the grooves, pits, and spillways must not be too deep to facilitate a good finish of the restoration.

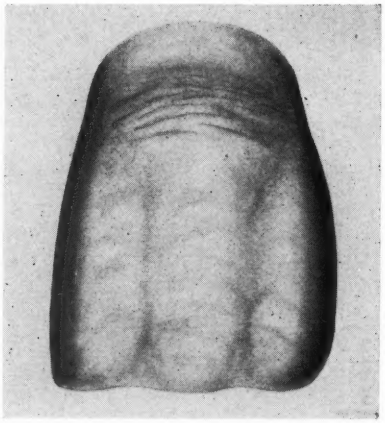


Fig. 3.

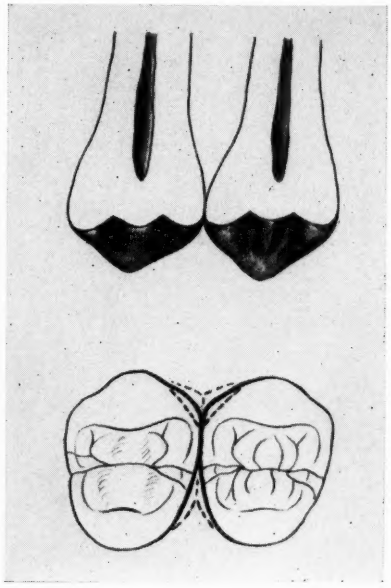


Fig. 4.

Fig. 3.—The pattern of lobes, developmental grooves, incremental lines, and faint surface markings are accentuated in this drawing for identification purposes.

Fig. 4.—*Above,* The mesiodistal section illustrates broad contact areas and well-rounded marginal ridges. *Below,* The normal outline of the proximal lobes of the first and second maxillary bicuspids. The dotted lines show various examples of faulty contours.

Rules 3 and 4 are frequently ignored. Obviously, these two rules determine the proper location and area of the contact of approximating teeth and the shape of the embrasures (Fig. 4). The importance of proper contact areas for maintaining healthy investing tissues and the effect of faulty contact areas on the gingivae cannot be overstressed.

The proper description of the contact surface is that of a contact *area* and *not* a contact *point*. The contact and the embrasures can be too large or too small in proportion to the size of the teeth. The contact can be located too far occlusally,

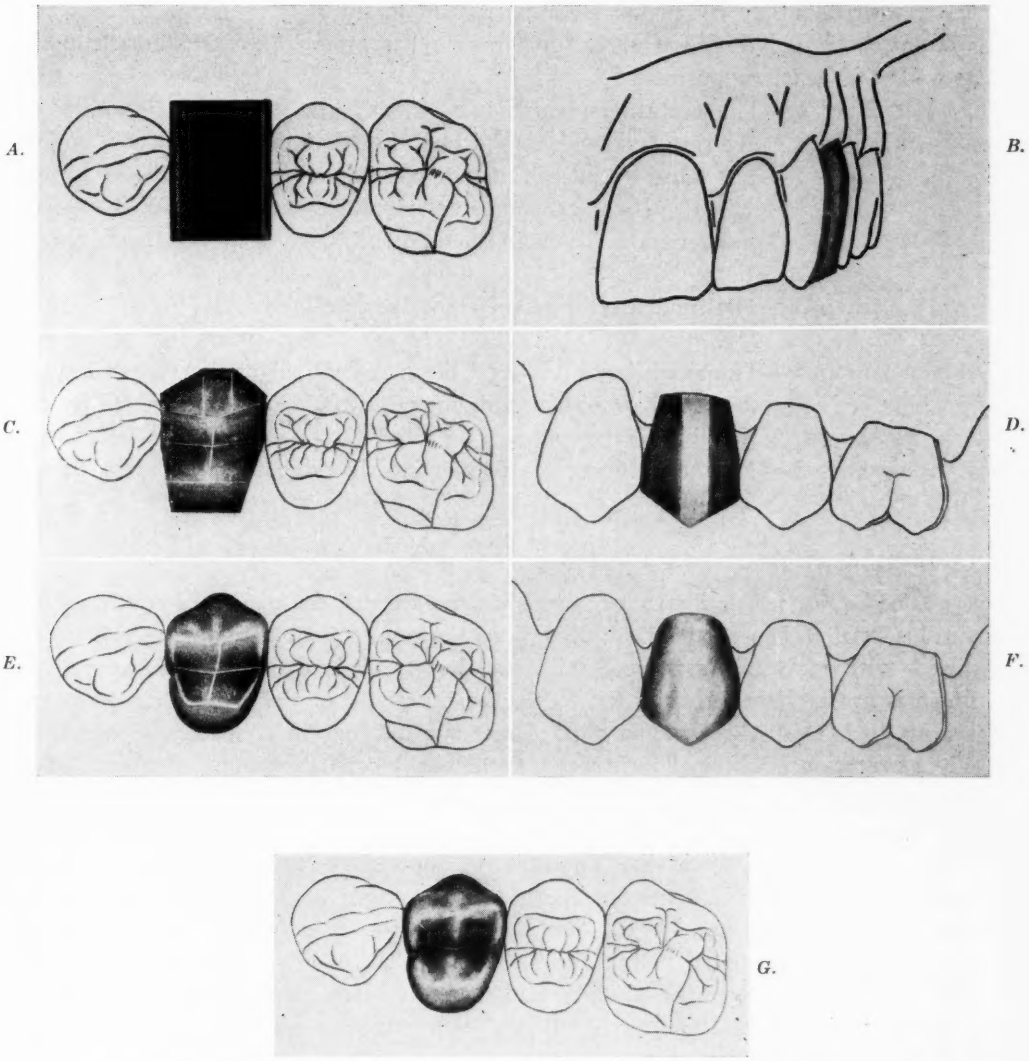


Fig. 5.—The progressive wax carving technique. *A*, The wax is placed and trimmed to the dimensional rectangle (step 1). *B*, The facial and lingual contours are established (step 2). *C* and *D*, The fundamental geometric shape is blocked out (step 3). *E* and *F*, The border surfaces, except the occlusal surface, are finished in detail (step 4). *G*, The occlusal surface is carved last (step 5).

gingivally, buccally, or lingually. When the marginal ridges are well rounded (rule 3), when the contact area is broad (rule 4), and when the fundamental geometric shape is correct, the contact area will be properly located and of the correct size while the embrasures form free escapeways.

CARVING

Planning of the carving procedure saves time and the end result is superior regardless of the material carved. A step-by-step procedure must be followed exactly, with each step completed before going on to the next. This is the key to efficient carving. The following carving method has proved successful for dentists as well as for teaching purposes:

Step 1.—The occlusogingival dimension and the buccolingual width of the restoration are established (Fig. 5, *A*).

Step 2.—The labial or buccal and lingual contours are established (Fig. 5, *B*). (If the carving involves more than one tooth, the teeth are separated to establish the mesiodistal width of the restorations.)

Step 3.—The fundamental geometric shape is established (Fig. 5, *C* and *D*).

Step 4.—The axial line angles and the marginal ridges are rounded, and the labial or buccal and lingual surfaces are finished (Fig. 5, *E* and *F*).

Step 5.—The occlusal surface or the incisal ridge is carved last (Fig. 5, *G*).

INSTRUMENTATION

The largest usable instruments possible are selected for the initial trimming of surplus wax. They should be heated very slightly to prevent chipping the wax. The border surfaces are finished with cold knives or lancets, while the marginal finish is accomplished against the tooth, the porcelain, or the die with a warmed spatula to burnish the wax margins. The cusp and marginal ridges are rounded. The restoration is checked for proper alignment, length, functional occlusion, and fundamental geometric shape.

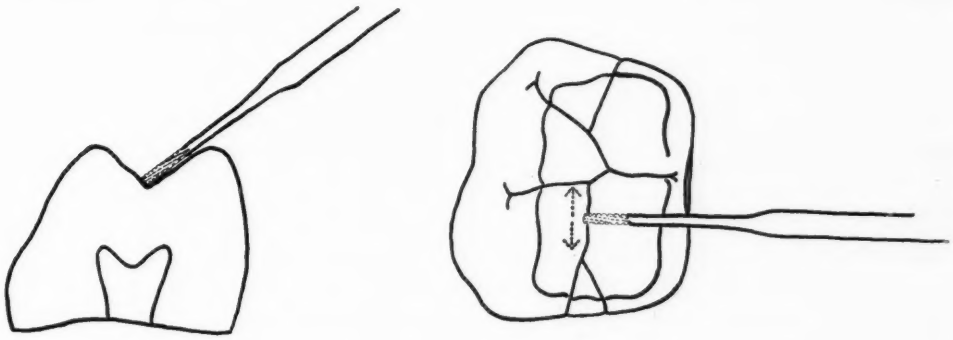
The occlusal surface is finished last with a small instrument such as a Hollenback 3 or a cleoid-type carver. The pits are established first and are located well inside from the marginal ridges. A groove connecting the pits forms the central groove. The buccal and lingual developmental grooves extend at first from the pits toward the marginal ridges and then turn sharply toward the cusp heights. They are well defined near the pits, and then they fade into shallow depressions. Carving of the occlusal and axial spillways which radiate from the pits across the marginal ridges completes the procedure.

An occasional blast of air will free the grooves of small wax chips or a small brush of medium stiffness can be used for the same purpose. A cotton pellet dipped in liquid soap is used for a final polish of all grooves, ridges, and fossae on the occlusal surface of the wax pattern.

POLISHING THE CASTING

A good finish of a gold occlusal surface is difficult to accomplish. Usually the casting needs some adjusting with a stone which destroys the grooves and spillways. These are recut easily with a No. 556 fissure bur. The cutting edge of the

bur is drawn lengthwise (not crosswise) along the groove. This establishes a more definite cut and permits more freedom of movement with the bur. Thus, it is possible to manipulate the bur with the same motion as a wax carving instrument (Fig. 6). Grooves cut in this manner can be restored to the natural shape carved in the original wax pattern.



A. *B.*

Fig. 6.—The cutting edge of the fissure bur is positioned to facilitate reshaping of the grooves and finishing of the sulci of a casting. *A*, The mesial view. *B*, The occlusal view.

The polishing process should retain the desired anatomy and at the same time eliminate all scratches in the grooves. This can be accomplished with pumice and a small brush wheel on a lathe or in a handpiece. Only slow motor speeds are used throughout. The wheel is first held against a bar of soap which serves as a carrier for the pumice. The soap and pumice-covered wheel is moved lengthwise along a groove. After two or three applications, any imperfections will be visible. They are corrected with the fissure bur, and the process is repeated to perfect smoothness. A short application of tripoli followed by jewelers' rouge will complete the polishing operation. Obviously, an occlusal surface should be highly polished to prevent clogging with food particles during mastication. Thus, the cutting efficiency of the restoration is maintained.

SUMMARY

The advantages of incorporating accurate tooth morphology into dental restorations were established. The dimensional rectangle and the fundamental geometric shape are aids in the development of the concept of tooth morphology. This concept forms the basis for the practical application of anatomic features in the construction of restorations. Systematic instrumentation and carving procedures promote the efficient reproduction of detailed anatomy.

The use of this procedure results in the saving of carving time, in anatomically accurate work, and satisfies the functional and esthetic needs of the patient. Furthermore, the dentist will become efficient in a facile and refined working method commensurate with the high standard of modern techniques in restorative dentistry.

School of Dentistry
University of Washington
Seattle 5, Wash.

MISCELLANEOUS

MAXIMUM MOUTH PROTECTION FOR CONTACT SPORTS

WILLIAM D. HEINTZ, B.A., D.D.S.*
The Ohio State University, College of Dentistry, Columbus, Ohio

THE NEED FOR and effectiveness of mouth protection in contact sports have been demonstrated in surveys and experiments involving thousands of high school and college athletes.[1] The available mouth protectors are practically 100 per cent effective against oral injury. However, there is still much confusion and lack of information among dentists regarding the most desirable or practical means of providing this protection. Face masks or bars do not take the place of a mouth protector or vice versa.[2]

The *major problem* is to choose the type of protector that the player can and will wear. Nearly all mouth guards—even ill-fitting ones—will provide protection when and if worn. None will do so when not in the mouth. Therefore, my concern for dentists, schools, and athletes alike is that the type chosen be useable. Unfortunately, some schools, athletes, and coaches have become disinterested in mouth protectors because of the money spent for unsatisfactory ones.

The best mouth protector, without qualification, is one formed over a cast of the mouth made from an impression made by a dentist. This can now be done quite easily.

EVALUATION OF THE TYPES OF MOUTH PROTECTION

Many kinds of protection are available, but they all fall into one of three types.[1]

The universal or stock type of mouth protector is intended to fit any mouth. This is the poorest form. The common complaints are that they are loose, cumbersome, interfere with talking and breathing, and require the jaws to be closed to hold them in place. They are often too thick on the occlusal surface to allow sufficient interocclusal clearance, and some are too thin on the labial side of the teeth. Vanet[3] says that the stock appliance is "as ancient and ineffective as a square wheel."

The second type includes those which are formed directly in the mouth. They are generally better in fit than the stock guards but are not nearly as good as the

Received for publication Jan. 10, 1958; revised by the author Feb. 27, 1959.
*Assistant Professor of Dentistry.

"custom-made" protectors. They are formed by carrying some kind of soft material to the mouth and allowing it to set to shape. One brand has a white outer rubber tray with a gutta-percha-like inner material. There is much objection to it because of its excess thickness, lack of elasticity and the resulting looseness, and its excess bulk. Another is made from a soft self-curing acrylic resin. It has better retention, but there is a "slow return" to its elasticity, making it loose for a time after biting on it. Its shape and occlusal thickness are the best of the commercial types. Recently, a similar protector made of a silicone material has reached the market. We have tested it with players, and it has better elasticity than the other guards of this type. However, in its present shape it is too short on the labial side of the teeth, too thick lingual to the anterior teeth, too thick on the occlusal surface (exceeding the normal interocclusal distance), and it is so short that it only extends back to include the first molar teeth. If these disadvantages are eliminated, it has good possibilities.

All of these mouth-adapted guards can be relatively inexpensive, and if used, they would be better if fitted by a dentist. They could be still better if they were adapted over a cast of the mouth. Their fit and retention is appreciably less satisfactory than that of the "custom-made" mouth guards.

The "custom-made" type of mouth guards is fabricated in various ways from one of several materials over a cast of the mouth made from an impression made by a dentist. Whatever the material, they generally provide the best fit and the proper bulk and thickness.

All factors considered, self-curing liquid latex improved by the addition of rayon flock is generally the best material available for securing maximum protection and fit. It can be formed into a mouth guard by a simple procedure. Several other materials can be used to form good mouth protectors, but they require waxing, flasking, and processing.

CHOICE OF TYPE TO BE USED

Nearly all kinds of mouth protectors will provide the needed protection when they are worn. The problem is, therefore, not primarily to find a kind that will protect but to select the type that will be *worn* by the players. The best fitting, most comfortable mouth guard is one that has been formed over a cast of the mouth.

Either for patients or for a team, the type of protection should be chosen that best fits the situation, but the choice should be made only after considering all of the factors involved.

If you are consulted by a team, you can point out the possibilities. Some teams have had the unhappy experience of spending money for protectors that the players would not wear. In such cases the unfortunate result can be that both the school and the players may be turned against this very necessary protection. The choice of the type of mouth guard alone does not insure satisfaction. If they are carelessly or improperly formed, any of them can be objectional.

Our survey of eighteen colleges and thirteen high schools revealed that *all* types of protectors can be "chewed through" by some individuals. For latex, the percentage was negligible,[1] but there was considerable variation. Some schools

reported none at all. Therefore, the variables of the personality of the player and the construction of the protector must be considered. One of the advantages of latex is that a replacement guard can be made readily and inexpensively, and the same cast may be used indefinitely. The addition of rayon flock toughens the latex appreciably, greatly improves the fit, and facilitates building it to the proper shape.

IMPRESSIONS AND CASTS

Remove any removable partial dentures that may be in the mouth. If fixed partial dentures or orthodontic appliances are present, block out all undercuts around them with a soft wax or a similar material to permit the removal of the impression without tearing or distorting it. Make an impression of the entire upper arch in an elastic impression material. If the lower jaw is prognathic, the impression and mouth guard are made on it.

Pour a cast in the impression immediately and carefully with a thick mix of stone. The cast is formed or trimmed only to the line where the reflection of the tissue begins (Figs. 2 and 3). This provides access to the border of the mouth guard outline for applying the material and checking its thickness. Bubbles in the cast must be avoided as they will interfere with the final fit. These are the only steps that must be done by the dentist.

The remaining procedures may be accomplished by anyone who will follow the instructions carefully.

After the cast has been removed from the impression, prop it up so air can circulate around it. Allow the cast to dry for at least two hours at room temperature or dry it in a warming cabinet for 30 to 45 minutes at between 150° and 180° F. (A warming cabinet can be made from a 9 by 12 by 18 inch box by inserting a light socket and a 100 watt bulb inside it.)

Outline the area of the cast to be covered with an indelible or very black pencil (Fig. 1). The line should be ⅛ inch short of the reflection on the buccal and labial surfaces. The anterior slope (rugae area) of the palate is included in the outline, and the line is continued diagonally back around the last molar teeth.

PREPARING THE MATERIAL

The material is a mixture of liquid latex and rayon flock. The liquid latex we use is XL rubber.* It costs about $4.00 per quart and about forty mouth guards can be made from one quart. Other liquid latexes may be equally satisfactory, but they should be tested before use. Not all liquid latexes will meet the requirements for mouth guards.

The flock† we use is a ⅛ inch length of rayon flock fiber. One-sixteenth inch lengths of rayon flock are *too short,* and nylon flock results in a very rough surface on the mouth guards. The flock too, is very inexpensive. One pound of it will be more than ample to mix with four quarts of latex. The proportions are two parts of the latex to one part of the flock by volume.

---

*Plastic Arts Studio, 3403 S. Madison St., Muncie, Ind.

†Plastic Arts Studio or the Rayon Processing Co., 1 Moshassuck St., Pawtucket, R. I.

To mix, pour a quantity of the latex into a glass container *first* and then add half as much flock to it. Always add the flock last. If it is placed in the container first, it will be compressed under the weight of the latex and thus prevent accurate measurement of the two materials. Mix the materials together well by stirring, but avoid "whipping" air bubbles into it.

When the mixture is applied properly, four layers of the material will form an adequate thickness for the mouth protector (Figs. 2 and 3).

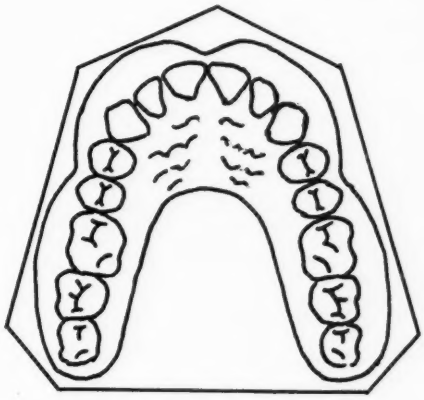


Fig. 1.—The outline of the mouth guard on the cast.

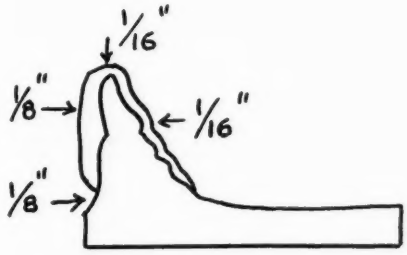


Fig. 2.

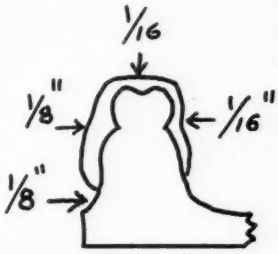


Fig. 3.

Fig. 2.—The correct thickness and extent of the protector over the anterior teeth and ridge.
Fig. 3.—The correct thickness and extent of the protector over the posterior teeth and tissues.

APPLYING THE LATEX

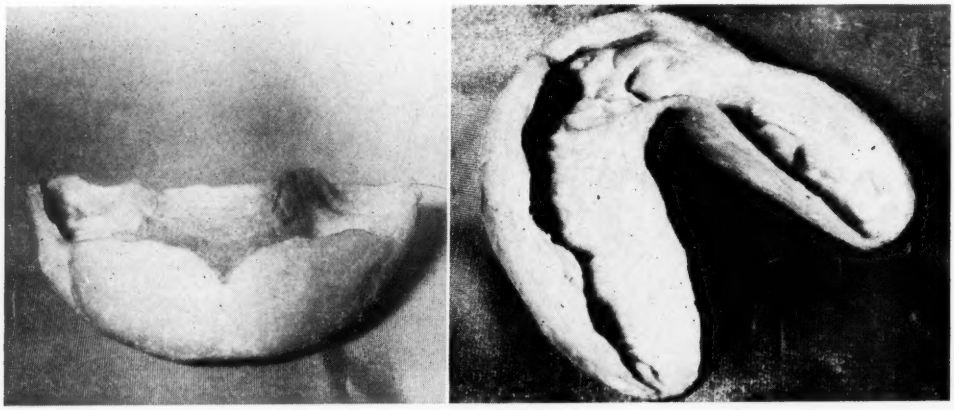
First Layer.—If a warming cabinet is used, have the cast warm. The cast may be used at room temperature but will require a longer time for each layer to cure.

No separating medium is needed on the cast. Use a cement spatula to apply the material. Cover the outlined area with a layer of the material a full millimeter thick. Begin at one end of the arch and spread the correct amount as you proceed. Stroke it with the spatula as you would in icing a cake. This will keep the surface smooth and avoid lifting up tufts of the flock. Push the material into all the interproximal spaces and into the grooves in the occlusal surfaces of the teeth. Use the spatula on edge to avoid trapping air bubbles. Do not try to stroke over a part that has been applied as it will have begun to air cure and dry and it will stick to

the spatula and raise rough areas on the surface. The first layer will seem to be a thin one as the moisture is absorbed into the cast.

It will take about 45 minutes to an hour for each layer to cure in the warming cabinet, depending, of course, upon the temperature. Neither the time nor the temperature is critical as long as the temperature does not exceed 180° F. (The material will be burned at temperatures above 180° F.)

The layer is cured when it loses its milky appearance and takes on a somewhat translucent amber color and when it will not retain a dent made by a fingernail or an instrument. At room temperature, several hours will be required for each layer to cure.



A. *B.*

Fig. 4.—*A*, The labial and buccal surfaces of the mouth protector are smooth, and adequate clearance is provided for the labial and buccal frenum. *B*, The lingual margins are very thin to avoid tongue and speech interference, and edentulous areas have been filled in.

Second Layer.—Apply the second layer slightly thicker than the first one. Apply more to the outside of the cast than in the palate to build up the intended thickness. Cure the second layer in the same manner as the first one.

Third Layer.—Apply the third layer in the same manner as the second. The thickness should be sufficient so that the next layer will easily finish to the desired final thickness. Cure as before. Letter names, numbers, or initials on the distobuccal surface with a ball point pen or damp indelible pencil after the third coat has cured.

Fourth Layer.—Check the thickness of the cured latex by puncturing it with an explorer in a number of places. Be sure the dimensions illustrated in Figs. 2 and 3 have been built up. Apply the fourth layer everywhere except over the lettering. After the ink has dried, cover the lettered area with a thin layer of straight latex (without flock). When this part is cured, its translucency will allow the lettering to show through. Be particularly careful to stroke the rest of the fourth layer smooth. When a slight crustiness forms (as curing begins) on the latex surface, moisten the spatula with water (do not have excess water on it) and stroke lightly over the latex surface to insure a smooth final finish (Fig. 4, *A*). Be careful to

avoid thinning out any areas, particularly over the cuspids (Fig. 4, *B*). Cure as before.

After the last layer is completely air cured, *do not remove* it from the cast, but put it in water and boil for about fifteen minutes. This insures a complete cure and minimizes the possibility of a "rubber" taste. Cool the cast and the cured mouth guard with tap water, and then the guard may be removed from the cast (Fig. 4).

While still wet, loosen the *outside edges* of the guard from the cast first. Never attempt to loosen it in the palate first because this would result in stretching it and harming its fit. After the outer edges are loosened, the guard can be removed. Where necessary, trim the edges to the outline made on the cast with sharp scissors. If any areas are too thin, the mouth guard can be replaced on the cast, warmed, and more material can be added and cured as before.

Try the guard in the mouth. If it is too long at any place, it can be trimmed further. The borders of the protector must be cut back about ⅛ inch from the frenula and the reflecting tissues.

PROVIDING MOUTH PROTECTION FOR TEAMS

Many people have become interested in mouth protection for players.

Service clubs, booster organizations, parents' groups, etc., are working with community dentists in many localities and offer their support and assistance to athletic teams. These public-spirited groups have voluntarily bought the materials and formed the protectors over the casts made by the dentists. Elsewhere the schools have taken the lead and approached the dentists and service organizations. Groups of students such as Hi-Y, art classes, student managers, and cheerleaders have formed the guards. These are some of the possibilities that might be applicable in your community. When this kind of cooperation exists, latex mouth protectors are the most economical, as well as having all the other advantages discussed. The dentists need only make the impressions and pour the casts. The other helpers can do a fine job in forming the guards.

The problem of a sufficient quantity of trays for making impressions for large groups can be solved by using plastic trays.* Ninety trays can be obtained for about $10.00. The average college squad will require about 55 medium trays and 35 large trays. The retention of the impression material in the trays can be improved by drilling additional holes in the sides of the trays.

To form the guards for a team, the best results can be obtained if no more than ten careful people are used to do the work. This facilitates the instruction and supervision and results in a much more uniform product than when too many workers are involved.

CARE OF MOUTH GUARDS

The mouth guard should be washed daily with soap and water. A perforated soap box provides a convenient place for keeping the mouth guard when it is not

*William Getz Corp., 7512 S. Greenwood Ave., Chicago, Ill.

in use. This allows air drying overnight. It is not necessary to leave the guard on the cast during the playing season. (To place it on the cast daily while wet would result in some odor, since it could not dry out completely.) Zephiran is an effective and economical germicide for sterilizing these mouth guards.

REFERENCES

1. Heintz, W. D.: Mouth Protection in Contact Sports—A Survey and Evaluation, Ohio High School Athlete **17**:147-150, 1958.
2. Wisconsin Interscholastic Athletic Association, Report of a Study, Marinette, Wis., April 22, 1956.
3. Vanet, R.: Gridiron Challenge, D. Survey **27**:1258-1260, 1951.

THE OHIO STATE UNIVERSITY
COLLEGE OF DENTISTRY
305 W. 12TH AVE.
COLUMBUS 10, OHIO

AMERICAN DENTAL ASSOCIATION 100 YEARS 1859 • 1959

COUNSEL TO THE AGING DENTAL PATIENT

ELDON D. BILLS, D.D.S., M.S.*
State University of Iowa, College of Dentistry, Iowa City, Iowa

HEALTH IS A CENTRAL FACTOR in every aspect of the older person's life. It influences every social, occupational, and economic strata of people; it affects all proposals for aiding the large numbers of older people in their family life, employment, recreation, and participation in community affairs. Facts about the relationship between health and aging are being sought by many—including the dental profession.

Until recently, very little attention had been given to the dental problems of the aged and the aging. With a population comprised of more and more older people, the dental and general health problems of this group become more pressing. "Sore" teeth and ill-fitting dental appliances make eating less pleasurable among the aged.[1] When the satisfaction and gratification of eating is decreased, the desire decreases and, in turn, a vicious cycle may ensue which leads to malnutrition and its accompanying ills—physical and mental deterioration. These changes of dental significance are not all health in origin. They may be of social, economic, psychologic, or physiologic derivation.

AGING

Aging is essentially a gradual deterioration of the body functions and abilities until they cease in the inevitable fate of all, death.[2] All people do not age at the same rate; thus, an individual has two distinct ages: his biologic age, which is the age of his tissues, and a chronologic age, which denotes the passage of time since his birth. Much of the life span is controlled by heredity, but a degree of modification can be made by environment, diet, emotional status, and medical care. As people do not age at the same rate, neither do their tissues. A person at 60 years of age may have a gastrointestinal tract comparable to that of a 40 year old, a nervous system of a 30 year old, a cardiovascular system comparable to that of a 50-year-old person, and the dental apparatus of an 80 year old, biologically. The sad part of dental health is that the dental age of the individual is more often comparable in difference to the example stated than need be.

DENTAL DISEASES

Most mental diseases or conditions may be termed truly chronic. Dental caries has long been recognized as one of the most universal chronic diseases of mankind and the most prevalent of all childhood afflictions. Other dental conditions of a chronic nature include periodontal diseases; joint problems associated with arthritis

Received for publication Oct. 31, 1958.
*Assistant in Instruction, Department of Prosthetic Dentistry.

and rheumatism; malocclusion, by loss of teeth and facial changes due to premature and insidious combinations of dental disorders. Many chronic diseases of senescence, which are not specifically dental, have distinguishable oral manifestations. Therefore, the dentist is very often in a position to detect early signs of other diseases such as tuberculosis, diabetes, cancer, nutritional disorders, and even high blood pressure.

It cannot be accurately stated how much oral or dental disease affects the length of life, but it can be accurately stated that the body cannot be entirely healthy without a healthy mouth. Along with the aging of other tissues and organs, the teeth also may be affected. They may become eroded, abraded, or diseased the same as other tissues and organs.

Wearing away of enamel may destroy the contact needed between the teeth and allow food to pack around them; the gums may then swell up and become inflamed, and gum disease (periodontal disease) has begun. If this process is unchecked, the loss of the teeth is certain, but this need not be if proper dental care is received and if home care is adequately performed.

The supporting structures of the teeth, jaws, salivary glands, and all conjunctional tissues are affected by senescence. The tissues may become shrunken and wrinkled, taking on a peculiar waxy appearance. The decreased flow of saliva may cause the mouth, nasal chambers, and throat to be quite dry.[3] These are not unusual happenings. They are simply part of the process of our body functions slowing down. However, more important in the loss of the natural teeth is a consideration of the previously mentioned factors. The common notion that periodontal disease occurs in the fourth and fifth decades of life has led to insufficient attention to this disease in earlier life. Even though cases take several years to develop, the fact that periodontal disease is readily evidenced after 40 years of age has made some believe that it was initiated at that time. Statistical studies by periodontists reveal that in persons under 31 years of age 53.5 per cent of the teeth are extracted because of caries and 9.3 per cent because of periodontal disease or conditions. In patients over 30, 22.4 per cent of the teeth are lost as a result of caries and 41.9 per cent due to various kinds of periodontal conditions. According to these figures, the rate of tooth loss goes up drastically due to periodontal disease as the age increases.

On reviewing age as compared to loss of teeth, people under 20 years of age suffer a great deal from caries and have very little periodontal disease, but at 20, when the number of cavities tends to decrease, periodontal disease begins to increase and increases continually after the age of 30. These observations, therefore, indicate that until the age of 30, for every 4 teeth lost due to caries, there is approximately 1 tooth lost because of gum disturbances. After the age of 35, for every 8 teeth lost due to periodontal disturbances, there is approximately 1 tooth lost through caries. Probably the majority of people that present themselves for treatment of gum diseases in the progressed stages after 35 years of age had the beginnings of their disease at about 18 or 19 years of age. At that time, the early clinical and roentgenographic changes should be discovered and their causes eliminated, thus stopping the progress of the disease early enough so that the advanced scars may be avoided for the remainder of the patient's years.[4]

CAUSE OF PERIODONTAL DISEASE

The cause of periodontal disease is a combination of factors rather than a single agent, and it consists of varying degrees of disturbing influences of three types. They are the irritations to the gums because the teeth are tipped and positioned wrong in the dental arch, causing food to bang or rub the soft tissue; deposits on the teeth and under the gums (tartar or calculus); fillings shaped incorrectly or not flush with the surface of the tooth; improper toothbrushing; a diet of soft food, tending to pack around the teeth and clasps or wires improperly placed on dental appliances. The teeth may not be functioning properly due to the way they come into contact with one another and, consequently, some of the teeth get overworked, become sore, and are lost. This loss may be due to biting habits (malocclusion), grinding the teeth unconsciously (bruxism), or due to the jaw muscles being too powerful as compared with the amount of bone and tissue supporting the teeth. Factors associated with the entire body may affect the dental structures. This may be a faulty nutrition. It is a well-known fact that boredom and poor diets will make us old before our time. Therefore, diets exert an important influence in the possible loss of our teeth.[5] Debilitating diseases, allergies, x-radiation in excess, avitaminosis, hormone imbalance, or pregancy may cause the supporting bone and soft tissue to become weak and incapable of carrying the load the teeth force upon them. The teeth are not anchored in bone but are suspended from the bony socket in a network of thousands of tiny ligaments called the periodontal membrane; thus, when we bite down on our teeth, these tiny connecting fibers exert a pulling tension on the bone which stimulates it to remain healthy as long as there is no infection or calculus present and as long as enough of these ligaments are present to support the load. The bony ridge around teeth, the alveolar process, is only present due to the stimulation of the teeth working within it. This stimulation keeps the constantly changing bone healthy. Once the teeth are lost, this healthy stimulation is gone and the bone gradually dissolves away due to a lack of need for it on the part of the body. This is a slow process as a rule, but it man be rapid, depending on the health of the person.

THE EFFECT OF DENTURES

When the teeth are extracted, the gums healed, and complete dentures constructed, we place upon this residual ridge, which is composed mostly of scar tissue, an appliance capable of exerting extreme pressures upon it. Pressure is an enemy to the human body because it will counteract the flow of blood through the area being pressed upon, and if the tissue does not have an adequate supply of nourishment, it becomes sick. The tissue begins to change by swelling and backing away from the irritating pressure. This is the reason that the average life of artificial dentures is from 1 to 5 years, depending upon the person's constitution and the manner and care in which the dentures were fabricated for each individual. After a time, shrinkage becomes so extreme that the space between the artificial denture and the tissue must be filled with material to take up the slack and make the dentures fit to the tissues once again. There is not such a thing as a really permanent denture; therefore the first set of artificial teeth must not be considered as the last ones. You

cannot do everything at once and then forget it, as you can with a monument, as previously explained.

PREMATURE AGING

Premature aging, mentally and physically, is often associated with early loss of teeth, destruction of the ridge (alveolar process), and the wearing of dentures.[2] It seems that if the patient can be given the opportunity by the medical profession to live a fairly comfortable and useful life until he is 70 years of age or over, the dental profession should make it possible for him to retain his dental apparatus in good health and comfort for that period of time.[6] The most important factor for the success of this proposal is an early start. Dental disease is more or less cumulative; hence the longer the patient lives the more factors have been in operation to cause the loss of the teeth. Each bout with disease leaves its scars in the mouth as in other areas of the body, all of which remain to a great extent to make us more susceptible to the insults of later life. In addition, the vitality and resistance of the gum tissues and bone are lessened in later life and render it more susceptible to the effects of trauma (mechanical damage) and complicate the dentist's efforts toward minimizing tooth loss and the maintenance of comfort, freedom from infection, and maximum masticating efficiency. A complete long-range program of the individual person with the dentist should consist of early dental and periodontal attention, preferably in the preventive stage.[7] Maintenance of the oral structure by regular prophylactic treatment and periodontal care to keep the dental apparatus modified to the constantly changing body tissues due to health and age is very important. This is to be done in addition to the regular attention given cavities and other dental conditions. After the completion of active dental treatment, every person should make arrangements for periodic dental check ups every 3 to 12 months. Home dentistry is a potent weapon in keeping the teeth in adequate health and safety. This is done by patient and judicious dental education to each individual on toothbrushing, home care, and proper nutrition, so that he can cooperate to the fullest degree. The cooperation with the physician in the early detection of diseases or deficiencies, in addition to the early discovery and elimination of local factors in the mouth that may interfere with good general health, is also a necessary adjunct.

SUMMARY

It is important for the modern dentist to be able to control dental and periodontal diseases so that their ravages will not cause such a loss of esthetics or efficiency which might invite emotional upheaval and make living miserable, even if the life span is increased. Complete dentures are to be delayed as long as possible by proper dental care. The extraction of the teeth and rapid conversion to complete dentures are to be avoided when possible because of the psychologic impact. When such a step must be taken, careful psychic readjusment should be brought about with careful consultation with the dentist. With such adjustment, happiness in the wearing of artificial dental appliances is possible.

REFERENCES

1. Burdick, D. L.: Pain in the Aged, D. Digest **59**:180-182, 1953.
2. Massler, M.: Geriatrics and Geriodontics, New York J. Den. **26**:54-63, 1956.
3. Goldman, H. M.: Geriatric Changes in the Oral Mucosa, J. D. Med. **9**:86, 1954.
4. Rudin, B. M.: Periodontia in Old Age. Vital Factors Influencing the Periodontal Care of the Aged Patient, D. Students' Mag. **32**:11-14, 34-36, 1953.
5. Fisher, W. T.: Prosthetic and Geriatric Nutrition, Oregon D. J. **24**:2-5, 1955; J. Pros. Den. **5**:481-485, 1955.
6. Ziegler, J. E.: Geriodontics, J. South. California D. A. **24**:29-44, 1956.
7. Crampton, C. W.: What to Do About Age and Aging, J. D. Med. **9**:70-80, 1954.

14 S. Linn
Iowa City, Iowa

DENTIST AND DENTAL LABORATORY TECHNICIAN RELATIONS

ACADEMY OF DENTURE PROSTHETICS*

THE AMERICAN DENTAL ASSOCIATION and the National Association of Dental Laboratories should be congratulated upon the progress of their program for the certification of dental laboratory technicians. It is the result of many meetings and thoughtful efforts of representatives of various councils of the American Dental Association and The National Association of Dental Laboratories. It is a wonderful accomplishment for both the dentists and the technicians and should result in greatly improved relations between these two groups.

Dentists should be much more judicious in their selection of dental laboratory technicians or laboratories to which they entrust the fabrication of their prosthetic appliances. Their knowledge of the art and science of dental laboratory technology and their productive ability as well as their ethical relation to the profession should be carefully evaluated. In the past many dentists have given too little consideration to either the ethics or technical ability of their prosthetic laboratory workers.

We, in the profession, should be aware of the developing critical shortage of dental laboratory technicians. There are at present only about 27,000 laboratory technicians in the United States. A great majority of these people are past middle age, and they are carrying excessively heavy work schedules to meet present needs. Expanding public demands upon the dentist's time for more and better dentistry necessitate his greater dependence upon the technician. Modern operative and impression procedures enable the dentist to do more chair-side work for more people in his work day, thereby placing greatly increased demands upon the dental laboratory technicians. These demands can be met only by an increased number of well-trained laboratory technicians.

The Council on Dental Education of the American Dental Association recognizes these facts and is encouraging a training program to improve the skill and efficiency of present dental laboratory technicians and to give preliminary training to young men and women interested in selecting this vocation.

It is the duty and responsibility of dentists in local areas to encourage qualified young men and women to interest themselves in the field of dental laboratory technology and to stimulate the formation of properly equipped and supervised schools of dental laboratory technology where those desiring to enter this field of endeavor receive adequate preliminary training.

In the past, many regional dental societies have looked with disfavor upon permitting laboratory technicians to attend their meetings when technical problems

Received for publication April 16, 1959.

*Dentist and Dental Laboratory Technician Relations Committee: A. W. Sears, Chairman, Jacksonville, Fla.; Clyde H. Schuyler, New York, N. Y.; and Ralph H. Boos, Minneapolis, Minn.

which might have been of interest to the laboratory technicians were being discussed. They have also looked with disfavor upon and discouraged dentist participation in educational programs sponsored by organized dental laboratory associations. The usefulness of the laboratory technician to the dentist is directly influenced by his knowledge and understanding of the science and art of dental laboratory technology. No one is as well qualified to give him this information or training as is the dentist. We, in the profession, must recognize it as our responsibility and duty to develop dental laboratory technicians so that they may better understand our needs and be better qualified to fill our prescriptions. If dentists assume this responsibility, they will receive increased respect from the technicians and an improved dentist and dental laboratory technician relationship will be assured.

Dental societies should invite and encourage laboratory technicians to attend meetings when the subject matter of their lectures is of mutual interest to both the dentist and the dental laboratory technician.

Dentists should assume the initiative in planning and sponsoring educational programs for the dental laboratory technicians and cooperate with them by giving lectures or clinics in laboratory procedures before recognized dental laboratory technician societies.

With appreciation of the great need for more and better trained dental laboratory technicians as a means of increasing professional efficiency in our effort to meet the increased demands of the public for dental services, the following resolutions were passed unanimously by the Academy, and copies have been sent to the Council on Dental Education of the American Dental Association:

RESOLUTION I

Whereas, the services of the dental laboratory technician as auxiliary personnel is an economic aid to the dental profession in its effort to meet the increasing demands of the public for dental services and,

Whereas, better trained technicians are desirable in the effort of the profession to render an improved service to the public,

Be It Resolved: that Fellows of the Academy of Denture Prosthetics use their influence that, when feasible, dental laboratory technicians be encouraged to attend dental society lectures when the subject matter is of mutual interest to both the dentist and laboratory technician. And that dental societies be encouraged to sponsor or support educational programs for dental laboratory technicians. And that dentists be encouraged to participate in educational programs sponsored by recognized groups of dental laboratory technicians presenting the various phases of dental laboratory technology.

RESOLUTION II

Whereas, there is at present a shortage of qualified dental laboratory technicians and evidence that the shortage will become progressively more acute,

Be It Resolved: that the Academy of Denture Prosthetics morally support and encourage a recruiting program by the profession to interest eligible young men and women to enter the vocation of dental laboratory technology.

RESOLUTION III

Whereas, there are nationally limited and inadequate facilities or schools for the training of young dental laboratory technicians or the continued training of those at present employed in the field of dental laboratory technology,

Be It Resolved: that the Academy of Denture Prosthetics request the Council on Dental Education of the American Dental Association to increase its effort to encourage local areas or societies to provide adequate training facilities for those desiring to enter the field of dental laboratory technology and for the continued training of those at present engaged in dental laboratory technology.

EDITORIAL

The Academy of Denture Prosthetics reports its actions relating to dentist and dental laboratory relations. They compliment both the Council on Dental Trade and Laboratory Relations and the National Association of Dental Laboratories for the program of Certification of Dental Laboratory Technicians that has been established. The Council on Dental Education also should be given credit for its efforts to establish standards for dental laboratory technicians. Throughout the greater part of the 100 years of the existence of the American Dental Association, little progress was made in assisting technicians in their preparations for their life work. Technicians were expected to be available when they were needed, but most of them had to train themselves by apprenticeship and trial and error. Many of these men who continued in their chosen work have succeeded in spite of the obstacles that were placed in their way. It is appropriate that they have an opportunity now for recognition that is due to them.

Something further is needed if the dental laboratory craft is to attract capable people who may become technicians and stay with it. It is the responsibility of the dental profession to assist in the training of new dental laboratory technicians wherever possible. If this is done properly, the beginning technicians can learn to do the nonchairside operations *the way their customer dentists have been educated to have them done.* This would be far better than for them to have to learn the laboratory techniques "second hand" and to have to wait a lifetime for recognition.

The dental profession is faced with a challenge. It must guide the education and training of the people who do an important part of the work involved in prosthodontics or be prepared to accept the inferior dental laboratory service which would be produced by inadequately trained or incorrectly trained technicians. The certification program is a step in the right direction. It should be followed by the development of an enlightened technician training program.

C.O.B.

BOOK REVIEWS

CLINICAL ENZYMOLOGY. By Gustav J. Martin, Sc.D. Boston, 1958, Little, Brown & Co. Pp. 241, illustrated, indexed. Price $6.00

Clinical Enzymology is an attempt to outline basic biochemical knowledge necessary for the clinician to understand the use of enzymes in medicine. The editor has only superficially accomplished this with chapters on protein biology and the chemistry and biochemistry of enzymes used clinically. Greatest emphasis is placed upon the parenteral use of enzymes, a chapter written by H. Tanyol, W. M. Swain, and J. M. Beiler. Other chapters were written by M. J. Sullivan, J. M. Beiler, G. Victor Rossi, and the editor. Each chapter is well documented with references so that the book is a convenient reference, especially for information on the parenteral and diagnostic use of enzymes. It appears to this reviewer that this collection of data is an attempt to promote the clinical use of certain enzyme preparations, namely, trypsin, chymotrypsin, streptokinase, deoxyribonuclease, hyaluronidase, and cholinesterase. It will be of little interest to the dental profession.

Walter J. Frajola, Ph.D.

OPERATIVE DENTAL SURGERY. By J. B. Parfitt, M.R.C.S., L.R.C.P., F.D.S.R.C.S. (Eng.), and W. B. Herbert, M.R.C.S., L.R.C.P., F.D.S.R.C.S. (Eng.). Baltimore, 1955, Edward Arnold, Ltd., and the Williams & Wilkins Co. Pp. 524, illustrated, indexed. Price $9.00

Operative dentistry was once defined as the procedures and preventive measures by which teeth may be conserved and the masticatory apparatus maintained in such a state that the general health will not be endangered. At that time, operative textbooks included almost every area of dental science. As dentistry progressed, many specialized divisions narrowed the field of operative dentistry so that it is presently confined to the prevention and treatment of diseases of the clinical crowns of teeth.

A textbook is essentially planned to be a teaching aid. Since operative dentistry once included every branch of dentistry except prosthodontics and orthodontics, the first texts fulfilled that obligation. This defenseless concept still establishes the scope of almost all operative texts. *Operative Dental Surgery,* by Parfitt and Herbert, follows the conventional pattern. In essence, it is a textbook concerned with dental practice.

There are twenty-seven chapters in its 515 pages. The effort to produce a comprehensive text must fail when 6 pages are devoted to pedodontics and 5 to gutta-percha. The chapter on periodontal disease, which excludes its pathology, contains 19 pages. Crown and bridge preparation, endodontics, and extraction of teeth receive similar attention. Unlike most operative texts, the major emphasis is not directed toward gold foil, to which only twenty-five pages are devoted. In all, those areas which are unrelated to operative dentistry circa 1955 are most superficially treated. By generous count, 287 pages are devoted to operative dentistry.

Critical examination of a text, even by the author, must bring to mind inclusions which might well be omitted and omissions which should have been included. This text is no exception. Such subjects as prescriptions for a dentifrice or an oral antiseptic, devitalization with arsenic sesquioxide, pulp mummification, seamless (shell) crowns, and others could be deleted.

Fluoridation as the most significant public health measure to reduce caries is omitted. The topical application of fluoride is mentioned and doubt is cast upon its efficiency.

The chapters on the treatment of dental caries, cavity preparation, and restorative materials are well described and arranged. Those chapters describing the elementary aspects of the subject are well expounded and illustrated.

This reviewer must express admiration to authors who possess that rare quality of courage so necessary to write a textbook in the most developmental era of operative dentistry. One could readily say of dentistry that its methods are either obsolete or experimental. This text written before 1955 could not include the most recent contributions to the selected field. One outstanding virtue is the authors' ability to write so deftly that a student can easily understand what he reads.

William Lefkowitz, D.D.S.

NEWS AND NOTES

MEETINGS

Society of Oral Physiology and Occlusion, Hotel New Yorker, New York City, Dec. 5, 1959. For further information write to Dr. S. M. Kelner, Secretary, 57 West 57th St., New York 19, N. Y.

Greater New York Dental Meeting, Hotel Statler Hilton, New York City, Dec. 7 to 11, 1959.

American Equilibration Society, Sheraton-Blackstone Hotel, Chicago, Ill., Feb. 4, 1960.

American Denture Society, Congress Hotel, Chicago, Ill., Feb. 5 and 6, 1960.

American Academy of Restorative Dentistry, Conrad Hilton Hotel, Chicago, Ill., Feb. 6 and 7, 1960.

American Academy of Crown and Bridge Prosthodontics, Conrad Hilton Hotel, Chicago, Ill., Feb. 6 and 7, 1960.

Southeastern Academy of Prosthodontics, Monteleone Hotel, New Orleans, La., April 29 to May 1, 1960.

American Association for Cleft Palate Rehabilitation, Brown Palace Hotel, Denver, Colo., May 12 to 14, 1960. For further information write to Dr. D. C. Spriestersbach, Department of Otolaryngology, University Hospitals, Iowa City, Iowa.

Academy of Denture Prosthetics, La Concha Hotel, San Juan, Puerto Rico, June 19 to 24, 1960.

The Mid-Continent Dental Congress will present a four-day postgraduate course by the Indianapolis Dental Research Group to be held at the Chase-Park Plaza Hotels, St. Louis, Mo., Nov. 1 to 4, 1959. Lectures will be given on restorative dentistry, oral surgery, complete and partial dentures, children's dentistry, periodontia, oral diagnosis, esthetics, and full mouth reconstruction.

For further information, write to James E. Brophy, Executive Secretary, St. Louis Dental Society, 8013 Maryland Ave., St. Louis 5, Mo.

ANNOUNCEMENTS

Reprints of the "Glossary of Prosthodontic Terms" may be obtained by writing to Glossary Reprints, 3939 Old Brownsboro Road, Louisville 7, Ky. The price is 50 cents per copy, with a 20 per cent discount allowed on purchases of 20 or more copies. Cash, check, or purchase order *must* accompany the order.

The University of Alabama School of Dentistry announces the following refresher courses:

Oral Rehabilitation, Oct. 3 and 4, 1959.

Hypnosis Applied to Dentistry, Oct. 10 to 12, 1959.

Insurance, Investments, and Estate Planning, Oct. 17 and 18, 1959.

Root Canal Therapy, Oct. 24 to 26, 1959.

Crown and Bridge Prosthodontics (with emphasis on pontic construction and fused porcelain veneers), Oct. 30 to Nov. 1, 1959.

For further information, write to Director, Refresher Course Program, University of Alabama School of Dentistry, 1919 Seventh Ave. South, Birmingham 3, Ala.

The Department of Stomatology, Division of Graduate Studies, School of Medicine, Boston University, announces the following postgraduate courses:

Tooth Preparation and Elastic Impression Materials in Crown and Bridge, Dr. Arthur Kahn, Oct. 15 to 17, 1959.

Periodontal Therapy, Dr. Henry M. Goldman, Dr. Bernard S. Chaikin, Dr. Gerald M. Kramer, Dr. William Pendergast, and Associates, Oct. 19 to 24, 1959.

Technics in the General Practice, Dr. Henry M. Goldman, Dr. David J. Baraban, Dr. Leo Talkov, Dr. Herbert Schilder, Dr. Gerald Kramer, Dr. Chester Landy, and Dr. Harold Berk, Oct. 26 to 31, 1959.

Occlusal Adjustment, Dr. Bernard S. Chaikin, Dr. Henry M. Goldman, Dr. Gerald M. Kramer, Dr. William Pendergast, and Associates, Nov. 2 to 7, 1959.

Full Denture Prosthesis, Dr. Chester Landy, Nov. 9 to 13, 1959.

Fixed Bridge Prosthesis, Dr. Leo Talkov and Dr. David J. Baraban, Nov. 16 to 20, 1959.

Endodontics, Dr. Herbert Schilder, Nov. 30 to Dec. 4, 1959.

Oral Pathology for Oral Surgeons, Dr. Jack Bloom, Dr. Henry M. Goldman, and Dr. Kurt Thoma, Jan. 11 to 16, 1960.

Removable Partial Denture Prosthesis, Dr. David J. Baraban, Jan. 21 to 23, 1960.

For further information and application, write to Director of Postgraduate Studies, Department of Stomatology, Massachusetts Memorial Hospitals, 750 Harrison Ave., Boston 18, Mass.

The University of Kansas City, School of Dentistry, announces the following postgraduate courses:

Preventive and Interceptive Orthodontics, Oct. 14 to 16, 1959.

Prosthetics, Nov. 4 to 6, 1959.

For further information and application, write to Postgraduate Division, School of Dentistry, The University of Kansas City, 1108 East 10th St., Kansas City 6, Mo.

The Ohio State University, College of Dentistry, announces the following postgraduate courses:

Complete Denture Prosthodontics, Oct. 12 to 16, 1959.

General Anesthesia, Nov. 2 to 6, 1959.

Oral Surgery, Nov. 9 to 13, 1959.

Indirect Technics in Bridgework, Nov. 18 and 19, 1959.

Bringing Operative Dentistry Up to Date, Nov. 30 to Dec. 4, 1959.

Crown and Bridgework, Jan. 25 to 29, 1960.

Pedodontics, Feb. 15 to 19, 1960.

Endodontics, March 1 to 4, 1960.

General Anesthesia, April 4 to 8, 1960.

Oral Surgery, April 11 to 15, 1960.

Clinical Periodontics, April 11 to 15, 1960.

Partial Denture Prosthodontics, May 2 to 6, 1960.

Complete Denture Prosthodontics, May 9 to 13, 1960.

Dental Drugs in Action, May 19 and 20, 1960.

For further information and application, write to Postgraduate Division, College of Dentistry, Ohio State University, 305 W. 12th Ave., Columbus 10, Ohio.

The University of Pennsylvania, School of Dentistry, announces the following postgraduate courses:

Histopathology of the Dental Pulp, Sept. 28 to Oct. 2, 1959.

Endodontics, eleven Wednesdays, beginning Oct. 7, 1959.

Restorative Dentistry Using Ultra High Speed Equipment, Oct. 14 and 15, 1959.

Complete Denture Prosthesis, Oct. 26 to 30, 1959.

Cephalometry, Nov. 23 to 25, 1959.

Hypnosis Applied to Dentistry, Nov. 30 to Dec. 2, 1959.

Dentistry for Handicapped Children, Nov. 30 to Dec. 2, 1959.

The Use of Ultrasonics in Periodontics, Dec. 12, 1959.

For further information and application, write to Director, Postgraduate Courses, School of Dentistry, University of Pennsylvania, 4001 Spruce St., Philadelphia 4, Pa.

Temple University School of Dentistry announces the following postgraduate courses:

Clinical Endodontics, Oct. 26 to 31, 1959.

Clinical Oral Pathology, Jan. 14 to 16, 1960.

Advanced Orthodontics, Jan. 17 to 30, 1960.

Anatomy—Head and Neck Dissection, Wednesdays, Feb. 3 to June 8, 1960.

Periodontal Prosthesis, Feb. 8 to 12, 1960.

Advanced Fixed Prosthesis, Feb. 8 to 13, 1960.

Present Day Periodontal Practice, one day a week for 10 weeks, starting Feb. 16 through April 26, 1960.

Practice Administration, Feb. 27, 1960.

Clinical Diagnosis and Oral Medicine, Feb. 29 to March 4, 1960.

Electronic Electrosurgery, March 18 and 19, 1960.

Full Denture Prosthesis, March 21 to 26, 1960.

Advanced Surgical Techniques in Periodontal Therapy, April 4 to 9, 1960.

Graduate Orthodontics, Sept. 12, 1960, a two-year course.

For further information and application, write to Dr. Louis Herman, Director of Postgraduate Studies, Temple University School of Dentistry, 3223 North Broad St., Philadelphia 40, Pa.

Tufts University School of Dental Medicine announces the following postgraduate course:

A Comprehensive Demonstration Course in Complete Denture Construction, Dr. Irving R. Hardy, to be given on the following Wednesdays: Oct. 28, Nov. 4, 18, and 25, 1959.

For further information and application, write to Director of Graduate and Postgraduate Studies, Tufts University School of Dental Medicine, 136 Harrison Ave., Boston, Mass.

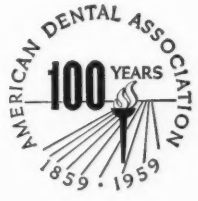
The University of Washington, School of Dentistry, announces a new Graduate Program leading to a Master of Science degree. The following courses are available to properly quali-

fied applicants: Fixed Partial Dentures, Operative Dentistry, Oral Pathology, Oral Surgery, Orthodontics, Pedodontics, Periodontics-Endodontics, and Prosthodontics.

For further information and application, write to Dr. Saul Schluger, Director, Graduate Dental Education, University of Washington, School of Dentistry, Seattle 5, Wash.

The Dental and Oral Surgery Service of The Mount Sinai Hospital in New York City announces that it is accepting applications for internships and residency for the calendar year beginning July, 1960. Application should be made as soon as possible since selections are generally made in December.

For further information and application, write to Dr. Max Fuchs, Assistant Director, The Mount Sinai Hospital, 11 East 100th St., New York 29, N. Y.



DIRECTORY

OFFICERS OF THE ORGANIZATIONS WHICH HAVE THE JOURNAL OF PROSTHETIC DENTISTRY AS THEIR OFFICIAL PUBLICATION

THE ACADEMY OF DENTURE PROSTHETICS

President: Harold L. Harris, 1325 East 16th Ave., Denver, Colo.
President-Elect: A. W. Sears, 2705 Atlantic Blvd., Jacksonville 7, Fla.
Vice President: Arthur H. Schmidt, Univ. of Puerto Rico, School of Dentistry, San Juan 22, Puerto Rico.
Secretary-Treasurer: W. Les Warburton, 807 Medical Arts Bldg., Salt Lake City 11, Utah.
Associate Editor: Vincent R. Trapozzano, 3900 Central Ave., St. Petersburg 11, Fla.
Next Meeting: La Concha Hotel, San Juan, Puerto Rico, June 19 to 24, 1960.

THE AMERICAN DENTURE SOCIETY

President: Carl T. Ostrem, 1107 Equitable Bldg., Des Moines, Iowa.
President-Elect: Lindsey D. Pankey, 152 Alhambra Circle, Coral Gables, Fla.
Vice President: LaMar W. Harris, 25 East Washington St., Chicago 2, Ill.
Secretary-Treasurer: Victor L. Steffel, The Ohio State University, College of Dentistry, Columbus 10, Ohio.
Associate Editor: Chester Perry, 16350 East Warren, Detroit, Mich.
Next Meeting: Congress Hotel, Chicago, Ill., Feb. 5 and 6, 1960.

THE PACIFIC COAST SOCIETY OF PROSTHODONTISTS

President: Charles Lipp, University of California Medical Center, College of Dentistry, San Francisco 22, Calif.
President-Elect: Arthur W. Spaulding, 4350 11th Ave., Los Angeles 8, Calif.
Vice President: Leon W. Marshall, 490 Post St., San Francisco 2, Calif.
Secretary-Treasurer: Willoughby R. Wright, 218 Medical Arts Bldg., Santa Monica, Calif.
Associate Editor: Roland D. Fisher, 604 South Central Ave., Glendale 4, Calif.

THE AMERICAN ACADEMY OF RESTORATIVE DENTISTRY

President: Allison G. James, 409 N. Camden Drive, Beverly Hills, Calif.
President-Elect: Carlisle C. Bastian, 22 Central Park South, New York 19, N. Y.
Secretary-Treasurer: Morton H. Mortonson, Jr., 735 N. Water St., Milwaukee 2, Wis.
Associate Editor: William A. Garrett, 833 Candler Bldg., Atlanta 3, Ga.
Next Meeting: Conrad Hilton Hotel, Chicago, Ill., Feb. 6 and 7, 1960.

THE AMERICAN ACADEMY OF CROWN AND BRIDGE PROSTHODONTICS

President: Stanley D. Tylman, Univ. of Illinois, 808 S. Wood St., Chicago 12, Ill.
President-Elect: William H. Hagen, 821 Medical-Dental Bldg., Seattle 1, Wash.
Vice President: George C. Porteous, 3005 Holmes Ave. So., Minneapolis 8, Minn.
Secretary: Willis E. Corry, 2165 Adelbert Rd., Cleveland 6, Ohio.
Treasurer: Joseph E. Ewing, 6901 Loretto Ave., Philadelphia 11, Pa.
Associate Editor: Stanley D. Tylman, Univ. of Illinois, 808 S. Wood St., Chicago, Ill.
Special Meeting: Statler Hilton Hotel, New York, N. Y., Sept. 12, 1959.
Next Meeting: Conrad Hilton Hotel, Chicago, Ill., Feb. 6 and 7, 1960.

THE GREATER NEW YORK ACADEMY OF PROSTHODONTICS

President: S. Charles Brecker, 2 East 54th St., New York, N. Y.
President-Elect: Gilbert P. Smith, 430 West 116th St., New York, N. Y.
Secretary-Treasurer: Jerome M. Schweitzer, 730 Fifth Ave., New York 19, N. Y.
Associate Editor: Gilbert P. Smith, 430 West 116th St., New York, N. Y.

THE SOUTHEASTERN ACADEMY OF PROSTHODONTICS

President: Walter A. Hall, Jr., P. O. Box 115, Loyola University, New Orleans, La.
President-Elect: E. C. Kelly Geiger, 7550 Biscayne Blvd., Miami Beach, Fla.
Vice President: William L. McCracken, School of Dentistry, University of Alabama, Birmingham, Ala.
Secretary-Treasurer: John H. Allgood, 516 Military Road, Columbus, Miss.
Next Meeting: Monteleone Hotel, New Orleans, La., April 29 to May 1, 1960.